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Food & Kindred Products	11,430	Petroleum Refining & Related Industries	3,417
Chemicals & Allied Products	10,731	Rubber & Miscellaneous Plastic Products	3,372
Systems Integrators & Engineering Design Firms	9,277	Miscellaneous Manufacturers	2,141
Primary Metal Industries	5,073	Stone, Clay, Glass & Concrete Products	1,758
Electric, Gas & Sanitary Services	4,055	Textile Mill Products	1,248
Pharmaceuticals	3,749	Tobacco Products	146
Paper & Allied Products	3,623	Total Circulation	60,000

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It's About Being Your Authority

WALT BOYES
EDITOR IN CHIEF
wboyes@putman.net

Elsewhere in this magazine, I've written about being a finalist for the Jesse H. Neal Awards. While finding another place to pat ourselves on the back is nice, that's not what I am writing about here. ● I want to talk about authority and what it means in a time when anyone can be an expert as long as they have an Internet access account and a burning desire to share their opinions. I want to talk about ControlGlobal.com and authority. It is our goal to become your authority for process automation.

Authority is a serious issue today. The Internet's basic anonymity means it's easy to set up as a pundit about just about anything, and nobody's the wiser if you sit your skivvies or are wearing a suit. And often nobody is the wiser—at least for a while—if you actually don't know what you are talking about, but sound (or read) really good doing it.

Essentially, authority means that the people who read your stuff do think you know what you're talking about. It really is something that is difficult to counterfeit for long. Pretending to be an authority in the process automation field is hard to do because the pretenders are easy to spot.

That's why we have so many real authorities writing for *Control* and ControlGlobal.com. Between Béla Lipták, Greg McMillan, Greg Shinskey, Dick Caro, Ian Verhappen, John Rezabek, Joe Weiss, our newest blogger, Dan Miklovic, our publisher Keith Larson and me, we have more than 375 man years of process automation experience.

What this gives us is the ability to answer questions authoritatively, describe applications and share the knowledge we've compiled with our readers. Lipták and McMillan answer questions every month in Ask the Experts and Control Talk. Ask the Experts has answered over 390 questions from concerned automation professionals since it was launched. Greg McMillan profiles and interrogates an automation authority every month.

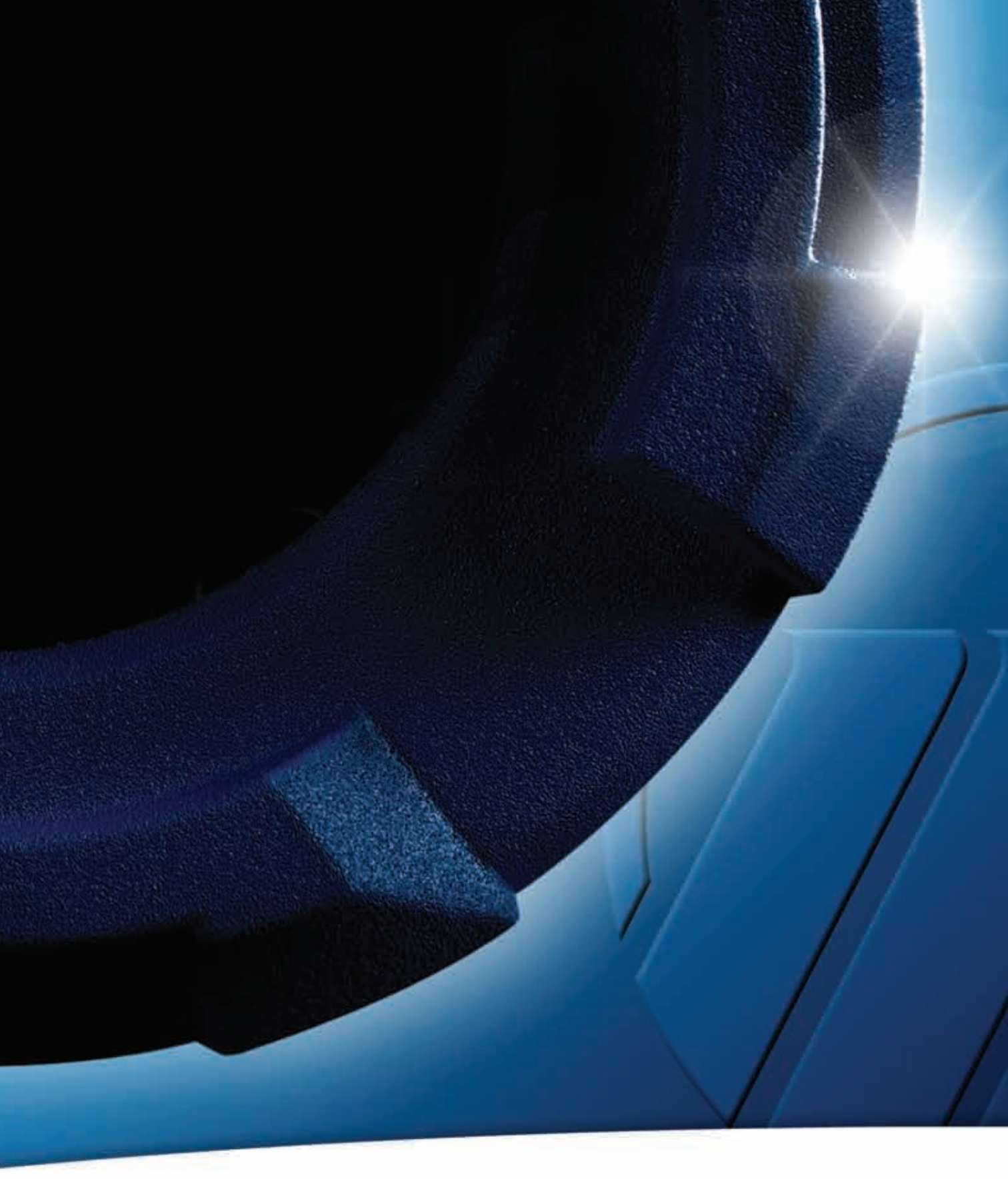
This is also the reason we do not allow vendor authors in *Control* and restrict them to white papers and vendor notes on ControlGlobal.com. It is certainly true that people in the vendor community have great knowledge and understanding of applications and problems in the process automation space. But sharing their understanding and knowledge with us comes at the potential price of favoritism toward their employer or their employer's favorite technologies. We provide one exception to this policy: If the author in question has achieved induction into the Process Automation Hall of Fame, we believe that his authority in process automation is unquestionable, and his (or her) insights trump employment.

Google respects authority, and when you see *Control* or ControlGlobal.com high on the response page in the search engine, that means that Google respects our authoritativeness as a magazine and combined multimedia information outlet.

We chose the name ControlGlobal.com specifically to take a North American print magazine and turn it into a global resource for process automation. We've succeeded pretty wildly. More than half of the visitors to ControlGlobal.com come from outside North America. We even have a small Spanish language information channel, Control en Español. We are always researching ways and partnerships to do more in other languages and other cultures. We delight in accepting articles from all over the world. We have had articles authored everywhere from Cleveland to China to Iran, and we want more.

We are determined to provide you with the most authoritative information—resources that you can use to do your job every day, wherever in the world your job may be. Drop me a line and let me know how you think we're doing.

The authorities writing for us have more than 375 man-years of experience in process automation between them.



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NATIONAL INSTRUMENTS

WALT BOYES
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wboyes@putman.net

ControlGlobal.com Norminated for Neal Award

As you are reading this, the *Control* team is waiting to find out if we have won a Jesse H. Neal Award for ControlGlobal.com. We are one of the four finalists in the category of "Best Website" for publications in the under $3 million revenue range. The Neal Awards are often called the "Pulitzer prizes for business-to-business media," and they honor excellence in editorial and design in business-to-business publications. Just to be a finalist is a real honor.

Control has won a Neal Award before, but this is the first time that our pioneering website has been recognized. We were one of the very first to recognize that a website was not a magazine. We moved in 2004 to make our website different and special, not just a copy of the paper magazine. That's why we renamed it www.controlglobal.com.

We decided in 2004 that we would make ControlGlobal.com an authoritative reference for process automation on a global scale. We were the first in the process automation space to begin a white paper library, hosting at last count over 1200 white papers, one of the most extensive sources of process automation knowledge in the world. We were also the first to pioneer promoting OEMs' white papers, so that the word would get out to the readers of *Control* and ControlGlobal.com about technologies the OEMs embrace.

We were one of the first to carry an editorial daily blog, Soundoff! We now host several blogs, including the influential Unfettered! blog by Joe Weiss, the internationally respected cybersecurity expert, and Control Talk by process automation guru, Greg McMillan. We were the first to carry video editorial, and some of our videos have drawn thousands of views both on our own site and on our YouTube Channel. We have published unique web content ranging from Béla Lipták's ebook on distillation to Greg McMillan and Stan Weiner's collected "Early Years of Control Talk," all the while publishing new product releases and news as we get them.

We are proud of what we have accomplished, and we are proud to be recognized by the Neal Award jury, whether we win or not. The most important thing though is that we continue to work every day at making the ControlGlobal.com experience better for our readers and our clients.

As editor in chief, I want to take this time to congratulate the entire team, especially Katherine Bonfante and Sarah Cechowski, our digital editors. Under Katherine's leadership, the ControlGlobal.com website continues to grow more impressive all the time. ■

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Please Recycle This Magazine

The Top 50 Automation Companies

I've been following your list for several years. It's always an excellent summary. One company to consider is Sick (optical sensing products). Its annual report indicates it did about €900 million last year.

TOM KNAUER
Tom_Knauer@sti.com

While I was studying your report about biggest companies in automation market I couldn't find some "big players," for example, Sick or Balluff. In 2011, Sick had about €902 of income. How do you get companies to your report?

PIOTR BURYŁO
burys@poczta.fm

[Editor's Note: Our Top 50 list is always a work in progress. Companies are added or subtracted as their fortunes change. We always welcome recommendations about companies we may have missed. For a complete explanation of the criteria we use for inclusion, go to p. 38 of the December 2012 issue, or go to www.controlglobal.com/articles/2012/top-50-how-do-we-do-it.html.]

Process Safety

Enjoyed your September 2012 editorial. Struck a chord with me. One other element that strikes me when we talk about plant safety is the condition of our aging refineries. Sometimes even the best maintenance practices fail to manage to keep some of these plants safe. They beg for refits and technology updates.

BP Whiting is in the throes of a mega expansion leaning on fieldbus. Not sure how much refitting is being done on existing processes. I'm sure there are plenty of processes there and in our other U.S. refineries that would be safer with investments in modern technology.

JIM SHIELDS
jim.shields@fluke.com

Wired vs. Wireless

I read this article (January, p. 47, www.controlglobal.com/articles/2013/verhappen-wireless.html), and it was very interesting. Thank you. There is an another solution that is between these two technologies; it's called powerline communication.

Wherever DC or AC powerline is required for the operation of any automation module, the powerline can be used to convey data between the modules without new wires.

My company has used this idea to develop semiconductors operating as UART transceivers over the powerline. You may transfer any number of RS232/RS485 bytes into the device, and the data will be received by all other devices connected over the powerline. Originally the device was designed for automotive; therefore it is noise-robust. Actually, many customers are using it for automation applications.

YAIR MARYANKA
yair@yamar.com

When Will There Be an App for That?

I enjoy reading *Control* magazine. The only question I have is when will you guys have an app for iPad which delivers *Control* magazine directly to the iPad like many other magazines?

CALVIN ROBERTSON
calvin.robertson@riotinto.com

[Editor's Note: Unfortunately, building a workable, user-friendly and attractive magazine app is a lot harder than it looks. Our staff is still in the process of exploring our best options for providing just such an app for Control.*]*

Correction

In the Readers' Choice Awards story in January (p. 56, www.controlglobal.com/articles/2013/nice-ice-readers-choice-awards.html), VEGA Americas was misindentified. It took first in the "Nuclear Level Gauge" category. We regret the error.

BÉLA LIPTÁK
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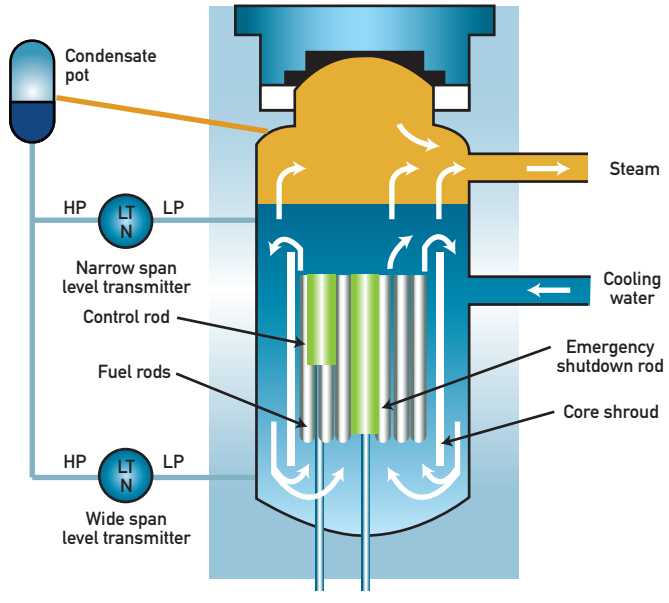
Automation Could Have Saved Fukushima

In the previous articles, I described how automation could have prevented the Three-Mile Island and Chernobyl accidents. Now I will do the same for Fukushima, but because of its importance, I will devote more than one article to it. In this first article I will concentrate only on the measurement of the water level in the reactor. If the Fukushima level detectors had operated correctly, and if the operators had flooded the reactors as soon as the earthquake was detected and would have started the venting of the hydrogen as soon as the fuel rods were uncovered, the hydrogen explosions would have been prevented.

The ex-core level measurement will approximate the in-core level only so long as the fuel rods are covered by water.

The Traditional Reactor Level Measurement

Figure 1 shows the traditional method used in the majority of nuclear reactors. Here, the cooling water enters a jacket-like space between the shroud and the reactor wall and is pumped downward by a jet dispenser (not shown). It travels down "ex-core" (outside the core) and then rises up "in-core." As it rises, the fuel rods heat it, and the water boils and, therefore, "swells."



THE PROBLEM WITH THE OLD WAY

Figure 1: This traditional system uses condensate pot compensated d/p transmitters. In such a system, if the condensate in the reference leg is lost (boils off), the level transmitters will over-report the level.

In most nuclear power plants, the ex-core level is measured by two differential pressure transmitters (Figure 1). One has a narrow span range (LT-N), and the other a wide one (LT-W). The LT-N is a better indicator of the surface of the boiling water, while the LT-W detects the total ex-core hydrostatic head (mass of water) in the reactor (the weight of the "collapsed water column").

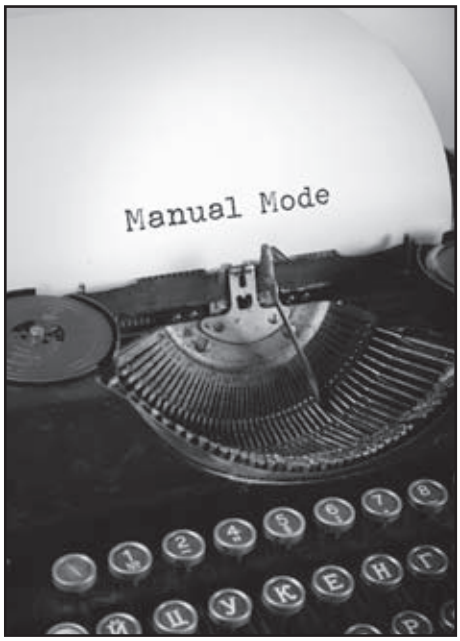
These level transmitters are installed with condensate pots that connect these reference legs ("wet legs") to the high-pressure side of the d/p cells. These level transmitters are "inverse-acting" (if the level rises, the transmitter output drops), because the hydrostatic head of the condensate in the reference leg is always higher than the weight of the water column inside the reactor. Therefore, the transmitter outputs are zero when the water level is at its maximum, and zero level generates a maximum output signal.

The reliability of this measurement depends on the assumption that the wet leg is full of condensate and at ambient temperature. During an accident, these assumptions can be wrong because the condensate in the reference leg can overheat or drain. Even under normal operating conditions, the more bubbles that form, the higher will be the apparent actual level, but the lower its density and, therefore, the detectors will under-report the level. Inversely, as the steaming rate drops, the density increases, and the actual level drops, while the level reported by the transmitters increases. Therefore, these level measurements are either unreliable or useless. The operators, after a while, notice that and start to disregard them, or even disconnect the automatic level controllers and try to manipulate the level manually.

The Fukushima Design

In the case of Fukushima, the design was even worse, because no transmitters were used at all.

(*Continued on page 23*)



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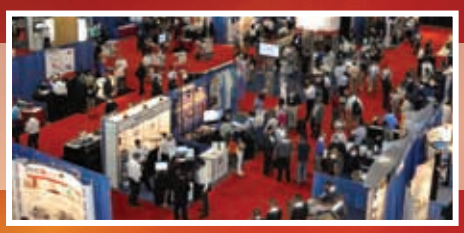

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(*Continued from page 16*)

Only d/p indicators were provided, and they were located in the control room requiring long lead lines. One of the lead lines detected the high-pressure reference from the condensate pot.

At Fukushima, soon after the cooling water pumps stopped, the condensate temperature in the uninsulated pot reached boiling point and boiled off. Once the lead line to the high-pressure side of the level indicator emptied, the indicator over-reported the water level in the reactors by several meters, which gave the operators a false sense of security.

Reliable Ex-Core Level Measurement

There are at least three ways to eliminate the level measurement error caused by the boiling off of the condensate from the wet legs. These are 1) Use different type level detectors; 2) Move the condensate pot, wet leg and d/p cell outside the primary containment; 3) Keep the existing system, but detect the height of the reference leg, and if it drops, compensate for that drop.

Choices 1) and 2) require plant shutdown, while 3) can easily be implemented without shutdown and without much expense (Figure 2).

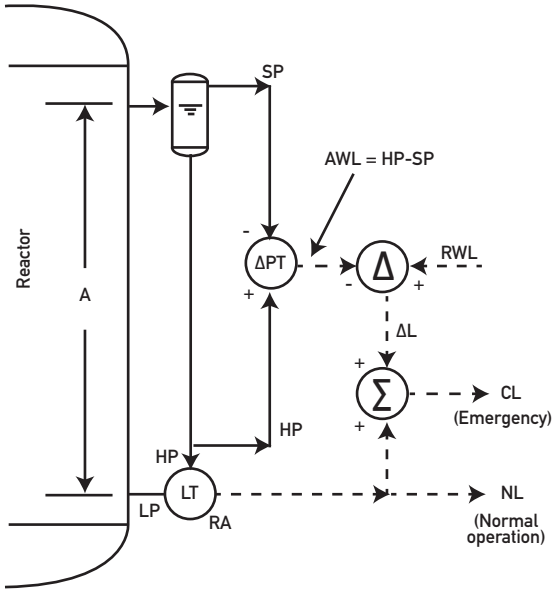
Figure 2 shows how the actual weight of the remaining condensate in the wet leg (AWL) is measured, and how that is subtracted from the normal reference wet leg (RWL). The calculated difference (ΔL) is the height of the lost condensate in the wet leg. Under emergency conditions, by adding this amount (ΔL) to the level reported by the d/p cell (NL), the corrected level (CL) is obtained. Both signals (NL and CL) should be sent to the control room to provide the operators with the needed information concerning the conditions in the reactor. Any number of d/p cells (LT) can be added to the reactor, and the closer they are vertically, the more accurate their readings will be.

In-Core Level Measurement

The ex-core level measurement will approximate the in-core level only so long as the fuel rods are covered by water, but once the ex-core level drops below the suction of the jet diffusers, it will not. Therefore, direct in-core measurement is also needed. In many cases, such as Fukushima, they were not provided.

One method of in-core level measurement is to correlate it with the gamma radiation distribution inside and outside the reactor. The vertical gamma radiation distribution is related to water level, because water is more of a moderator than steam. On the other hand, because gamma radiation is also a function of the neutron flux and of the speed of water recirculation, special correction models and algorithms are needed to obtain the water level from gamma radiation distribution.

Other possible ways to detect in-core level (or steam/water ratio) are based on the thermal or electric conductivity, or neutron modulation differences between water and steam.



A	Height of reference leg
AWL	Actual wet leg weight (hydrostatic head)
CL	Corrected level signal to control room
d/p	Differential pressure
HP	Pressure on the high-pressure side of the d/p cell
LP	Pressure on the low-pressure side of the d/p cell
LT	Level Transmitter
NL	Normal level—level measurement signal during normal operation (AWL = RWL)
RA	Reverse acting (the output signal drops as the detected differential pressure rises)
RWL	Reference wet leg weight (hydrostatic head = SpG x A)
SP	Steam pressure
Δ	Difference (subtraction)
ΔL	The amount of wet leg loss (RWL – AWL)
ΔPT	Transmitter detecting the actual height of the reference leg
Σ	Summation

HOW TO CALCULATE THE CONDENSATE LEVEL

Figure 2: This control system continuously calculates the correct level (CL) if, during an emergency, some or all of the condensate has boiled off from the wet leg. Converting a traditional system (Figure 1) to this one is easy and does not require a plant shutdown.

Dr. David Nyce designed such a thermal conductivity-based in-core level sensor for the Knolls Atomic Power Laboratory. In that design, a number of metal probes of different lengths are inserted, each equipped with two vertically separated thermocouples (TC). The one located at the tip is heated, while the second, unheated reference thermocouple is a few inches above the tip. In case of this sensor, if water covers both TCs, the temperature difference (ΔTw) will be lower than the temperature difference (ΔTs), when both are covered by steam.

If all nuclear power plants used the correct level measurement design shown in Figure 2, their safety would be much improved. ■

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Why Couplers Aren't Commodities

JOHN REZABEK
CONTRIBUTING EDITOR
JRezabek@ashland.com

When fieldbus pioneers expressed concerns about single points of failure in simple two-wire buses, Relcom (www.relcominc.com) engineered and patented the "SpurGuard," a compact assembly that could be substituted for pluggable terminals on their wiring blocks. Any "spur" (what fieldbus calls a single-pair drop to a device) fitted with a "SpurGuard" could sustain a water-logged or otherwise short-circuited condition without cratering the whole network.

SpurGuards were expensive, so Relcom and its competitors began to design and manufacture "couplers," wiring blocks pre-fitted with short-circuit protection for each spur. Since about 2009, end users have been able to choose from a wide selection of couplers that are registered and tested by the Fieldbus Foundation (www.fieldbus.org). So can couplers be procured on the basis of cost only?

There are distinctions. If you're creating a wiring block or "brick," you have to make choices regarding how many spurs you can wire to each brick.

Pepperl+Fuchs (www.pepperl-fuchs.us) has one of the wider selections of bricks, which can be purchased with 4, 6, 8, 10 or 12 spurs per brick. P+F and Phoenix Contact (www.phoenixcontact.com) go a step further to optimize scalability in their lines of snap-together modular coupler hardware. Both P+F's RM-SP* line and Phoenix Contact's FB-ET lines allow you to build up couplers with between two and 26 spurs. A pluggable bus rail extends the bus for up to a half-dozen more modules, each extending the base unit in increments of four spurs. These solutions may provide the optimal solution for those who want to minimize junction box size.

I used to think the original Relcom "Megablock" had a comforting ruggedness due to its physical mass, but Relcom's Cyrus Kelly explains the "heft" came from "potting"—encasing the entire electronics assembly in a substance that sealed the circuitry from its environment. Cyrus's research revealed that potting was no better than the significantly more cost-effective technique of "conformal coating"—sealing the circuit with what amounts to a coating of a similar non-conductive substance, such as acrylic lacquer. In other enhancements to the second generation of bricks, Relcom engineers reduced the component count by 35%, which can be broadly tied to a proportional increase in mean time between failures (MTBF). So perhaps "heft" isn't an infallible indicator of reliability or ruggedness.

MooreHawke's (www.miinet.com) couplers are extremely rugged. The case of the TG200 series is metal, and an eight- or 12-block spur block might break a toe if you dropped it on your foot. MooreHawke also has unique "auto terminator" circuitry that adds the required impedance-matching terminator at the furthest end of the trunk automatically. While other couplers may add a short-circuit load of 50 mA to 60 mA when a spur is shorted, MooreHawke couplers add only a few, once a short-circuit is detected.

R. Stahl (www.r-stahl.com) offers another line of couplers that have low-quiescent short-circuit current. This can be a factor when one is computing the maximum power budget for a segment: The 30 mA you save could facilitate adding an additional device or allow test equipment to be connected without causing communication errors. Stahl couplers also have special accommodations to limit inrush current when powering up an entire segment, and circuitry to tolerate more than one short circuit without an increase in the total current load.

Cobalt Process (https://cobaltprocess.com) doesn't believe in salesmen and caters to savvy end users who know what they want and don't want to pay for marketing overhead.

Arguably, any of the certified couplers will be one of the most reliable components of one's fieldbus networks. But there are ample features and distinctions that have their appeal for individual users and cultures. ■

Potting is no better than the significantly more cost-effective technique of "conformal coating" for ruggedizing couplers.

IAN VERHAPPEN
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INDUSTRIAL AUTOMATION NETWORKS
iverhappen@industrialautomationnetworks.com

ISA100.11a — Round 2 Begins

The ballot for 65C 714 Committee Draft Vote (CDV), which relates to standard "IEC 62734/Ed 1: Industrial Communication Networks—Wireless Communication Network and Communication Profiles—ISA 100.11a" has failed. The process begins to look like a reprise of the Fieldbus Wars of the 1990s, although, one hopes, not as acrimonious.

The country-by-country voting results are interesting in that of the 22 votes cast, 19 Participating Member countries approved the standard, with 12 in favor (63.2%) and seven against (31.8%). The discrepancy in the voting numbers is caused by the fact that there are also five Observing Members among the 22 that count in the second criterion of overall voters. With the approval criteria being 2/3 approval of all Participating Member countries (12/19 = 63.2%) and ¾ approval of *both* Participating and Observing Members (7/22 = 31.8%), the ballot was rejected under both criteria.

In addition to the vote results themselves, the National Committees (NC) provided about 194 comments of which 42 were editorial, with the balance requiring a technical resolution. The Working Group IEC 65C/WG 16 is responsible for resolving these comments. It held a meeting in January to begin the comment resolution process. At that meeting, 98 comments have been accepted and will be directly incorporated into the next revision of the IEC document. Fifty-nine comments were "accepted in principle/in part," and the remaining 37 were rejected by the committee. The next step will be to revise the CDV to incorporate the changes and then distribute a second CDV, probably in the April/May time frame. If this CDV is approved, normally after a five-month balloting period, a Final Draft International Standard (FDIS) ballot can be conducted toward the end of this year; therefore, the earliest that ISA100.11a can be published as an IEC standard is early 2014. ISA100.11a is still an ANSI-approved standard; however, it is also likely that the comments adopted by the IEC committee will be incorporated into the next revision of the ISA document.

As the Canadian chairman for IEC TC65 and a member of Canada's SC65C committee, under which this standard falls, I found it interesting that "IEC 62657-2 Ed1: Industrial Communication Networks—Wireless Communication Networks—Part 2: Coexistence Management," in circulation over roughly the same time frame, was approved with comments and will be registered as an FDIS in May this year. There were a total of 25 ballots received for this CDV with seven abstentions, 22 P-Members voting, 20 affirmative (90.9%) and two negative votes.

Work also is ongoing in the area of coexistence by the major control systems suppliers that will have a positive impact on wireless field or sensor network reconciliation. This group, known as the "Heathrow team," may also work towards resolution of other issues difficult to resolve within the standard itself.

However, to really affect change, end users need to express their opinion in one form or another. Though some companies are doing large installations, I believe many are in fact voting by effectively saying, "We are going to wait until the standards issues are settled before investing in a significant way."

Voting with your wallet is certainly one way to vote. However, to make effective change and directly influence the outcome of this dispute, end users should vote with their time by participating in the appropriate standards committees. In the case of WirelessHART and similar trade consortia-driven standards, this is not directly possible at the standard writing level. However, it certainly is true with ISA-based committees which are mandated to have a balanced representation of participants. A third way to participate is to become involved in your country's IEC National Committee. In the case of IEC, practically all the automation-related standards are developed by IEC TC65 (www.iec.ch/tc65) and its various subcommittees. ■

To directly influence the outcome of this dispute, end users should vote with their time by participating in the appropriate standards committees.

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Fluke Recalls Digital Clamp Meters

Improperly fastened circuit assemblies can cause shock, electrocution or burn hazards.

Fluke Corp. is voluntarily recalling certain Fluke 373, 374, 375 and 376 digital clamp meters manufactured between Sept. 1, 2010, and Oct. 31, 2012.

The printed circuit assembly in these units may not be properly fastened to the test lead input jack. This may result in inaccurate voltage readings, including a low- or no-voltage reading on a circuit energized with a hazardous voltage, presenting a shock, electrocution or thermal burn hazard.

This voluntary recall involves Fluke digital clamp meters with the model and serial numbers listed above. Any serial number preceded or followed by the letter "R" is *not* affected by this recall notice.

Model	Manufacture Dates	Starting Serial Number	Ending Serial Number
Fluke 376	Sept 2010 – Feb 2011	14270001	15909999
Fluke 375	Sept 2010 – Mar 2011	14270001	16079999
Fluke 374	Oct 2010 – Feb 2011	14270001	16379999
Fluke 373	Oct 2010 – Oct 2012	14270001	21950000

Fluke is warning owners of these meters to stop using them immediately, and return them to Fluke for repair. Fluke asks users to send only the clamp meter; any test leads/boxes/manuals that are sent with the unit will *not* be returned.

To contact Fluke for information on how to have the units repaired, either go to www.fluke.com/37x-recall to register the affected product online as part of the recall, or call 877-564-7180 for information and to request a postage-paid mailing envelope for the unit.

Emerson Upgrades Automation at Russian Power Plant

Emerson Process Management has completed an automation upgrade for an 800-MW unit at Russia's Surgut-2 Power Plant in Chelyabinsk, Russia, one of the largest thermal power stations in Europe. Emerson, the main automation contractor for the project, completed the upgrade during a four-month shutdown.

Unit 3 of the Surgut-2 power plant, owned and operated by E.ON Russia, will now take advantage of Emerson's PlantWeb digital automation architecture with the Ovation expert control system, which was designed specifically for power applications. In addition to upgrading the Unit 3 control system, instrumentation, control valves and other related equipment, Emerson also modernized controls for the fluid end of the turbine set; reconstructed and equipped the Unit 3 control room; provided engineering and installation services; certified compliance with requirements of Russia's System Operator of Central Dispatch Administration of the Unified Energy System; and assisted with unit start-up. As part of the project, Emerson also installed AMS Suite predictive maintenance software.

BIG POWER

The 800-MW unit at the Surgut-2 Power Plant in Chelyabinsk, Russia, one of the largest thermal power stations in Europe.

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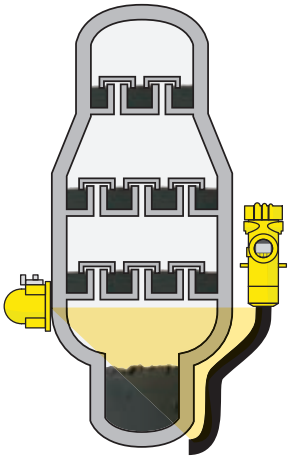

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power and frequency control and coordination. It also provides real-time monitoring of equipment and timely notification of abnormal situations, and helps determine equipment health, so technicians can schedule maintenance and repairs more efficiently.

"Implementing a full-scale, high-performance control system and ensuring its full availability for launch during a four-month shutdown was a real technical challenge," said Stepan Okunkov, manager of CIS Power & Water Solutions Engineering Center of Emerson Process Management. "But we were able to achieve this goal through the excellent teamwork between Emerson and Surgut-2 power plant specialists from E.ON Russia."

The Surgut-2 station uses natural gas coming from the Tyumen Region's oil fields. Based on annual output, the plant is one of the biggest thermal power stations in the world, producing more than 35 billion kWh per year.

Are Teens Afraid of STEM Careers? Are Parents to Blame?

While 95% of teens agree that risk-taking is required for innovation in science, technology, engineering and mathematics, or STEM, careers, 46% say they are afraid to fail or are uncomfortable taking risks to solve problems, according to an ASQ survey conducted by Kelton Global.

The survey, which was fielded in January in advance of National Engineers Week, Feb. 17-23, reveals that students' pressure to succeed may be driven by parents, of which 81% say they are uncomfortable if their child does not perform well in sports, extracurricular activities or social situations. Of those parents, 73% say they feel uncomfortable when their child gets bad grades.

While nearly half of students are afraid or uncomfortable about failing, Cheryl Birdsong-Dyer, an ASQ member and professional process engineer, said failing—and more importantly, trying again—is a pivotal skill in problem solving.

"If one does not take risk, they risk not solving the problem," she said. "As educators, professionals and leaders we need to reinforce to teens that every failure is an opportunity to learn and grow. Teaching teens that it is okay to take risks and sometimes fail will build their confidence and ultimately their knowledge base of science, technology, engineering and math."

Girls Fear Failure More

According to the survey, 88% of students say they feel the pressure to succeed, of which 71% say failing a class makes them feel they have not succeeded. Seventy-eight percent of girls feel unsuccessful when they fail a class, compared to 64% of boys. When faced with a difficult problem to solve, only 11% of students are happy because they enjoy solving problems, according to the survey results. Fifty-eight percent

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of girls say they feel uncomfortable or afraid when facing a difficult problem in school. In comparison, only 34% of boys feel uncomfortable or afraid when asked to solve challenging schoolwork.

ASQ CEO Paul Borawski says, "We need to teach today's students how to take risks and fail, so they feel comfortable when faced with challenging work. If students are going to cure the next deadly disease, solve the energy crisis or end world hunger, they have to be prepared to fail and learn from those failures."

About the Survey

The ASQ STEM survey was conducted Jan. 3-11, 2013, among 511 American youth, ages 12-17, and 391 parents using an email invitation and an online survey. Margin of error was ±5% for the parent sample and ±4.3% for the youth sample.

Krohne Offers Online Academy

Krohne Inc. has announced the availability of the Krohne Academy, featuring web-based training on measurement technologies and other topics of interest to process measurement personnel. The audio-enhanced, interactive training courses are ideal for process measurement personnel who work with different measurement principles on a daily basis, as well as students and others who wish to update their knowledge of measurement techniques and applications in technical installations.

The academy's training courses are published on a robust and engaging eLearning platform. Each course is focused on either a measurement technology, such as variable area, vortex, ultrasonic or mass flow, or on a more general topic, such as the basics of gas measurement or pipeline leak detection.

The online Krohne Academy is vendor-agnostic and not specific to individual products and/or industries. No special knowledge is required, but it is useful to have basic technical understanding of process measurement. Training is free and there is unlimited use of the learning platform, which is available in English, German, French, and Chinese. Online registration is available at https://academy-online.krohne.com/.

Course participants can use the academy courses at any time of the day and at their own speed. Learning progress evaluation and certification of attainment is available. Participants can even engage and interact with Krohne technical experts on specific issues. ■

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Contents Under Pressure

Control's Monthly Resource Guide

Every month, *Control*'s editors take a specific product area, collect all the latest, significant tools we can find, and present them here to make your job easier. If you know of any tools and resources we didn't include, send them to wboyes@putman.net, and we'll add them to the website.

SELECTING A PRESSURE TRANSDUCER

This free, downloadable white paper discusses the top five selection considerations and the top three design considerations for selecting the correct pressure transducer for your industrial applications. To get the white paper, go to http://tinyurl.com/al96eyu.

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PRESSURE INSTRUMENTATION BLOG

American Sensor Technologies Inc. (AST) has released a new blog for pressure instrumentation and related items. AST hopes to keep customers up to date with the latest product updates, inform visitors of new developments within the sensor industry, and educate the marketplace on how sensors are being used and applied. AST has begun posting to the blog with topics ranging for oxygen pressure transducers to eliminating diaphragm seals. The direct link to the blog is at www.astsensors.com/blog/.

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HOW TO MEASURE PRESSURE

This free tutorial from the NI Developer Zone series covers the basics of pressure measurement. Topics covered include what pressure is, pressure sensors, pressure measurement, and signal conditioning used to measure pressure. The tutorial includes basic equations, drawings and references for further study. The direct link is at www.ni.com/white-paper/3639/en.

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THE BIG BOOK OF PRESSURE INSTRUMENTATION

The Open Book Project offers a free, downloadable, 655-page PDF, "Lessons in Industrial Instrumentation," by Tony R. Kuphaldt, c. 2008. Pages 289-347 of this book cover pressure instrumentation, including continuous pressure measurement, mechanical and electrical pressure elements, force-balance and differential pressure transmitters, and pressure sensor accessories. The direct link to the book is at http://openbookproject.net/books/socratic/sinst/book/liii_0v2.pdf.

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PRESSURE MEASUREMENT FUNDAMENTALS

This handbook from Ametek covers the basics of pressure measurement, including deadweight pressure testers, the calibration of deadweight testers, monometers, secondary comparison pressure standards and selection of pressure measurement standards. The PDF is free and downloadable, but registration is required. The direct link is at http://tinyurl.com/74odkox/.

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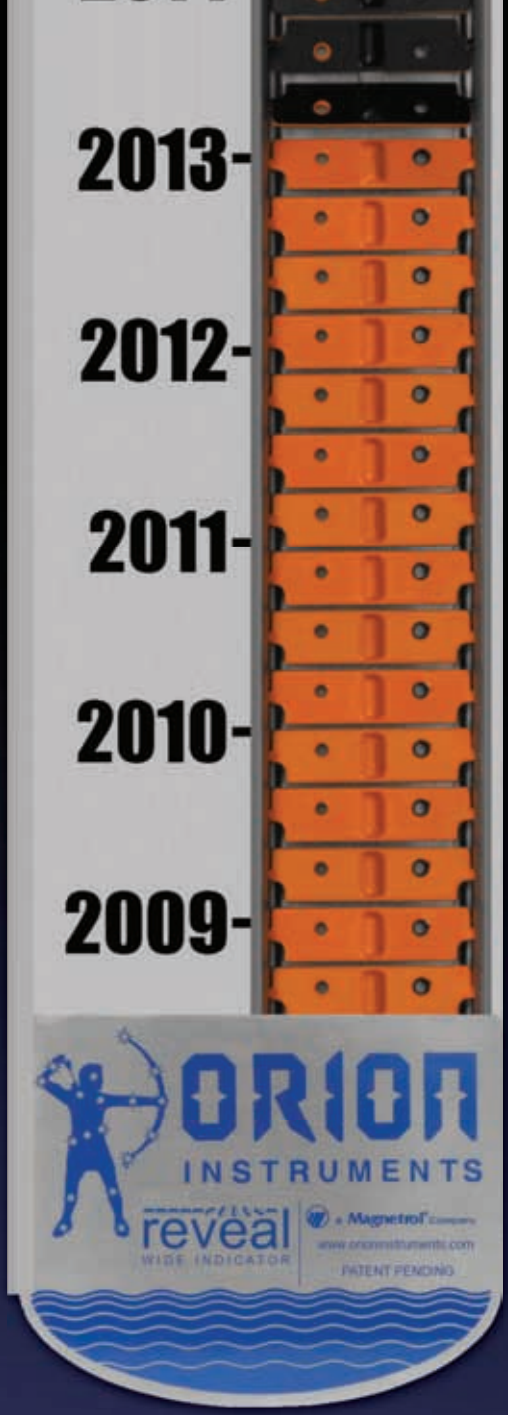

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Operator Performance Pumps Up

Prioritized data, simpler displays, human-factors-designed equipment, fatigue-reduction efforts, alarm planning and other tools can all improve situational awareness and operator performance. So how much do you need of each?

by Jim Montague

Just as there are many ways to improve process controls and automation, there are many useful ingredients that go into improving operator performance. And, just like mixing up a nutritious fruit smoothie or protein shake, the best recipe for optimal operator performance means finding the tools and methods you need most and will suit you best.

These components include better prioritized data and alerts, simplified displays and software, improved ergonomics, targeted training and simulations, new policies on alertness and physical fitness, and numerous software tools and proactive procedures. All can help enhance operator performance and improve the safety and productivity of process applications, and lately they're being followed by a bunch of other helpful tools and software.

For instance, Dave Strobhar, chief human factors engineer at the Center for Operator Performance (www.operatorperformance.org), reports it's testing the semantic procedure analyzer (SPA), which is learning software that recognizes and flags terms, updates all applicable documents and makes it easier for operators to organize and update routine and emergency procedures. SPA was developed by Penn State University with contributions from center members Chevron (www.chevron.com) and Yokogawa Corp. of America (www.yokogawa.com/us). The center also just developed its display metrics toolkit (DMT) that lets operators measure their performance with different graphics, which can help them create better tools for individual applications. "We now have a range of tools and methods for evaluating performance, so operators and managers can more easily develop the best solution for them," says Strobhar.

Collaboration Aids Simplification

One of the best ways to improve operator performance is to get the operators involved early in designing solutions that can meet the specific needs of their applications.

"When we implement interfaces and control systems, we get the operations guys on the team developing the graphics as soon as possible," says Keith Jones, president of systems integrator Prism Systems Inc. (www.prismsystems.com) in Mobile, Ala. "So after we program the PLCs and DCSs and bring their data to the HMIs, about 80% of the input on what those displays should include and how they should look has already come from the operators. Once operators get some real input on changes they become very proud of them."

Despite these potential benefits, Jones adds there can still be a lot of reluctance to change by older, entrenched operators when Prism is asked to upgrade brownfield applications. "We've seen some really horrible HMIs that pack as much information and color onto one screen as possible. This was done because HMIs and screens used to be a lot more costly, but they make it very hard to pick out what's important," explains Jones. "This is why we began following and preaching the Abnormal Situation Management Consortium's (www.ASMconsortium.net) principles on prioritizing data and using minimalist-style graphics and quad-display systems. But even though monitors are cheaper and more effective now, it's still hard to sell operators on them, and management doesn't want to increase their burden or add more training."

Jones reports that some HMI software can allow users to keep the look of their old, custom screens, but this can make them harder and more expensive to upgrade in the future, so it's better to make the jump to common, standard HMI function blocks and configuration tools, such as Siemens Industry's (www.usa.siemens.com) Simatic PCS 7 and HMI Plus software. "If we can convince a user to change to standard HMI, then we can begin to clean up the graphics and do training on them," says Jones.

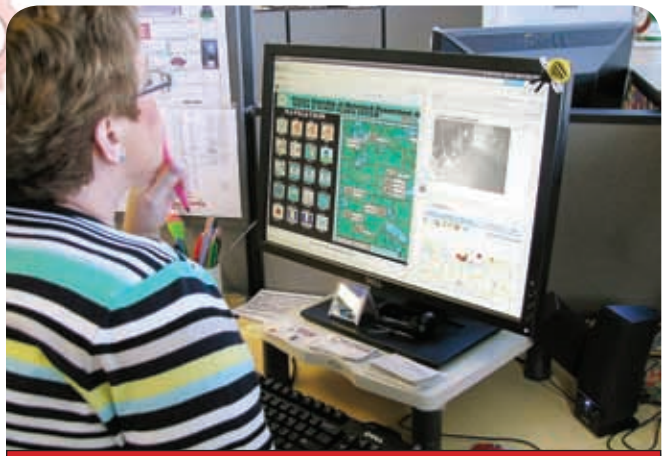
Jones adds that PCS 7 has conversion tools for migrating tag databases and hardware-defined tasks from old PCs and unsupported software to new systems, which can greatly reduce the costs of HMI and DCS upgrade projects. "We can even leave some old hardware in place and run it in parallel with a new HMI system for awhile," explains Jones. "Then, if mistakes are made, we can make a punch list and check them by comparing the old and new systems."

Enhancing the HMI

If one of the best ways to aid operators is to fix what they're looking at, are there common recommendations for improving those screens and other HMIs? No doubt.

"Poor basic control performance is rampant, including poor tuning and poorly maintained valves," says Bill Hollifield, principal alarm management and HMI consultant at PAS Inc. (www.pas.com) and co-author with Hector Perez of the *High-Performance HMI Handbook*. "This is like sending a race car driver out on the track with lousy brakes. Neither the operator nor the process can perform well with poor basic control. Fortunately, many alarm systems are being fixed, and alarm management has become well-accepted. However, alarms are a small part of the overall operator HMI, and so high-performance HMIs based on new principles for creating screens are needed to correct poor, widespread and ingrained HMI practices. A proper HMI increases operators' situation awareness and their ability to detect and successfully resolve abnormal situations."

Hollifield adds that PAS recently worked with the Electric Power Research Institute (www.EPRI.com) to proof-test these high-performance HMI concepts at a large coal-fired power plant using several operators and a full simulator. "The tested HMI included proper hierarchy and embedded knowledge, and we found that operator results were better when handling significant abnormal situations," adds Hollifield. "Besides showing useful information instead of just raw data, displays should be designed in this hierarchy that



PRIORITIZED PROCESSES

Photo by Bill Fritz at Waterford DPW

Figure 1: A staff member at Waterford DPW consults several operating platforms at the same time, including water/wastewater process controls and security cameras, with help from GE Intelligent Platform's Proficy Vision and Proficy Workflow software.

provides progressive exposure of detail. Displays designed from a stack of schematic designs will not have this. They'll be 'flat' like a computer hard disk with one folder for all the files. This doesn't provide optimum situation awareness and control. A four-level hierarchy, including operation overview, unit control, unit detail and support and diagnostics displays, is desired. For example, Figure 2 is an operation overview from a large power plant. We often hear, 'But it doesn't look like a power plant!' Correct! Does your automobile instrument panel look like a diagram of your engine? The display is designed so important abnormal conditions and alarms stand out clearly." [A whitepaper by PAS on these high-performance HMI principles and the EPRI project is located at http://tinyurl.com/a8tdjln.]

Holistic Human Factors

Besides improving HMIs and displays, enhancing performance also means assisting the physical eyeballs viewing those screens—especially when their owners' attention falters and they get tired. Limiting work hours and potentially dangerous fatigue has long been mandated for airline pilots, first responders, truck drivers and other professions, but it's not as well-known or established in many process operations—where many managers and operators rely on too many overtime hours and consecutive workdays.

To remedy these dangerous situations, the U.S. Dept. of Transportation's Pipeline and Hazardous Materials Safety Administration's (www.PHMSA.dot.gov) latest rules took effect in September 2012, and they require pipeline operators to use display graphics that employ human-factor designs; reduce operator fatigue by limiting consecutive hours and days worked to a more normal weekly schedule; establish thorough alarm procedures; document and learn from incidents; and pay fines up to $1 million or more per violation, according to Ian Nimmo, president of User Centered Design Services Inc. (www.mycontrolroom.com).

"More process facilities are investing in control room management (CRM) and human-factor principles, and they're taking countermeasures against fatigue, such as deploying 24/7-style chairs, brighter lighting and better temperature control, providing exercise equipment and enforcing regular breaks," explains Nimmo. "They're also monitoring hours worked by operators and calculating the relative risks of

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incidents, which is going to force some to hire more staff. Besides providing more human-factors graphics, process managers also need to conduct a risk assessment to make sure their operators can handle the number of alarms they're going to get. Then, they need to take a holistic CRM approach, evaluate the roles and responsibilities of their operators and define exactly what they're supposed to do in specific situations, including normal and abnormal operations and in emergencies."

Curing Computer Clutter

While software and computers of all types are indispensable to manufacturing in general and process control and automation in particular, the downside is an increasingly impenetrable jungle of software applications and packages that don't share data fast enough or allow operators to access information they need to make crucial decisions. Fortunately, some solutions are coordinating different types of software and bringing them into more manageable formats.

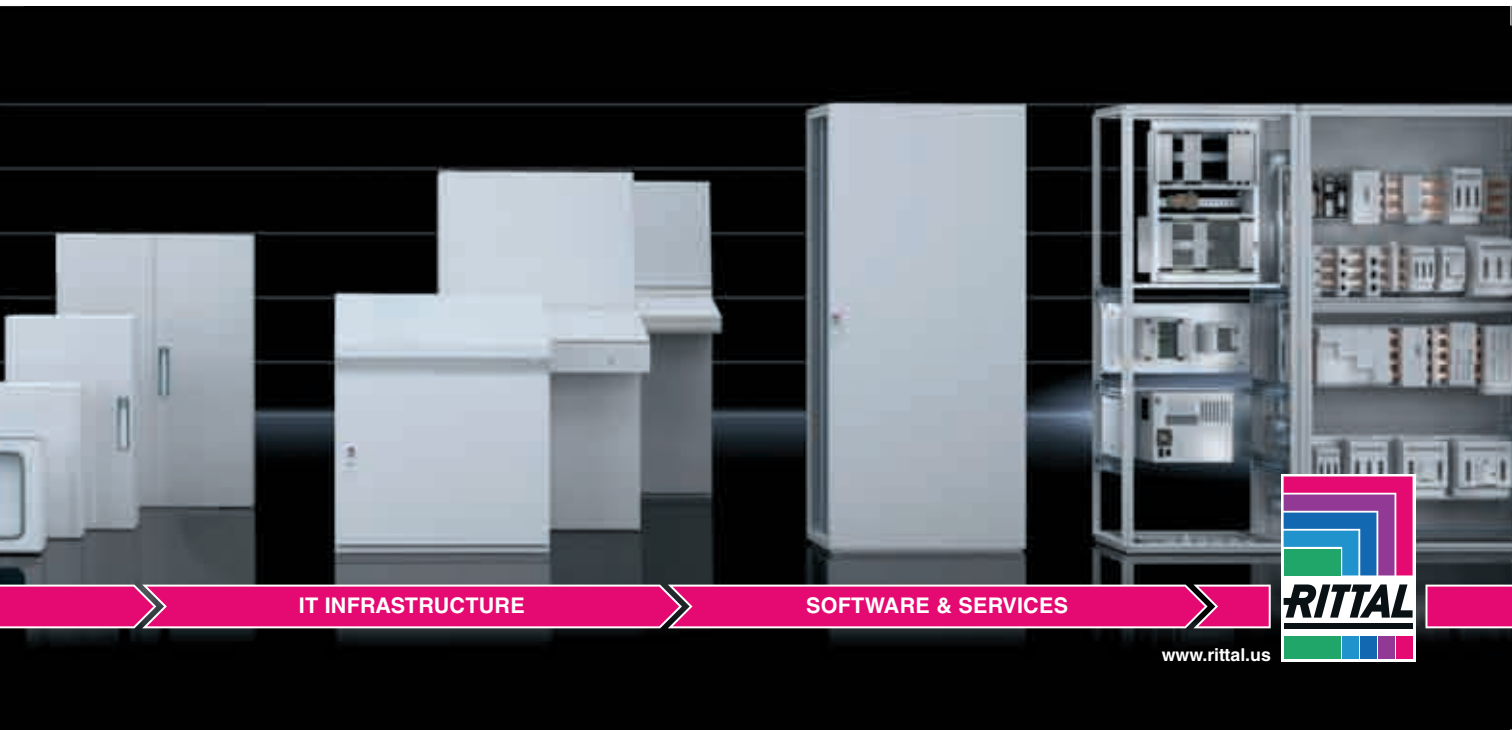
For instance, Waterford Township's Dept. of Public Works (DPW, http://twp.waterford.mi.us/Departments/Public-Works.aspx) uses many types of process control, maintenance, documentation, asset management and enterprise software to operate its water collection, distribution and wastewater systems, which cover 36 square miles in Michigan and serve about 75,000 residents. The water system pumps and treats about 8 million gallons per day of groundwater from 20 wells at 12 plants and 100 remote sites, and the wastewater system maintains 300 miles of sanitary sewers and sends the township's wastewater 30 miles away to Detroit for treatment.

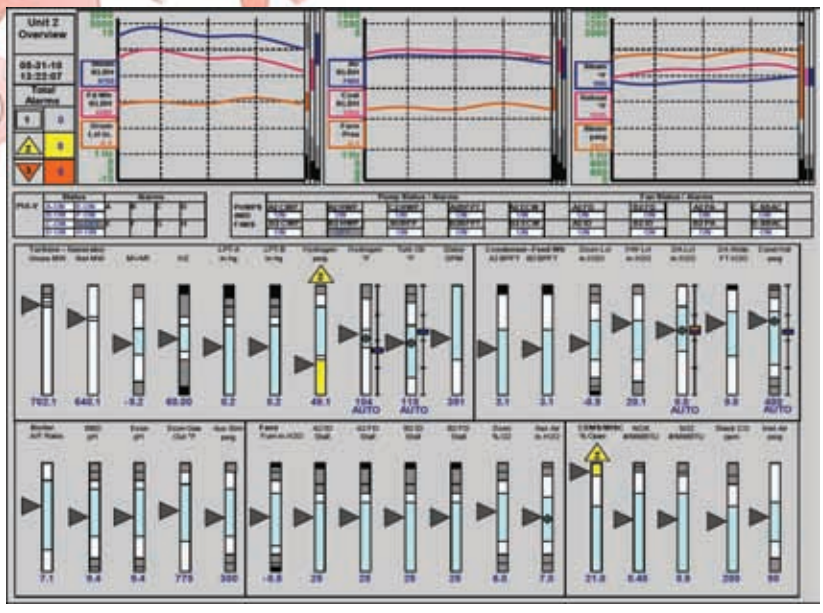
Bill Fritz, PE, Waterford's public works director, reports

BETTER INTERFACES = BETTER OPERATORS

There are a few basic steps needed to upgrade human-machine interfaces (HMIs) and their software, so they can contribute more fully to helping operators and their applications. Keith Jones, president of system integrator Prism Systems, reports these are some of the most crucial:

- Involve operators up-front, discuss why an upgrade is important, secure buy-in and allow input on planned changes.
- Decide on what HMI platform to use and seek proficiency in it by aligning with a system integrator and supplier partners.
- Renew focus on overall business goals, understand required operations and define or redefine displays and graphics functions to best serve those tasks. For example, don't make displays that merely recreate P&IDs, but instead evaluate the manufacturing process to determine what operators truly need to know, ask them what screens they use most and build HMIs based on that data.
- Draft a project team and then cross-pollinate by sending at least one person from the end-user's side to the system integrator's side and vice versa.
- Hold regular visits and face-to-face and WebEx meetings to update participants on the project's progress, and seek new input.
- Develop HMI project scope, plan and acceptance schedule, including layout, graphics placement, navigation procedures, alerts and alarms, user identification and other security requirements.





Graphic courtesy of PAS Inc.

OPTIMAL OVERVIEW

Figure 2: An optimized overview of a large power plant doesn't look like an abstract graphic of a power plant. Instead, PAS uses prioritized trend data and human-factor principles to make important abnormal conditions and alarms stand out clearly.

that the water/wastewater systems operate hundreds of pumps, valves, actuators, water quality and other equipment, which are monitored by more than 1200 I/O points and networked via Modbus TCP/IP, a high-speed Ethernet backbone with twin servers, and remote radios and 100 live-video security cameras at its pumping stations. All of this data comes into an unmanned cubicle, where it's been managed by GE Intelligent Platform's (GEIP) Proficy iFix software, and then reports, e-mails and alerts are pushed out to DPW personnel on their laptops, tablet PCs and smart phones.

Also, about two years ago, Waterford DPW added Proficy Workflow software, which automates more processes, serves as an electronic user manual, and performs exception-based reporting, which notifies users of problems so they don't have to go find them. For example, the department

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built algorithms and templates to indicate if pairs of pumps are alternating correctly at 62 of its pumping stations. This allows Proficy Workflow to provide alerts when the pumps aren't synched properly, so individual visual checks by the operators aren't required anymore.

"It's been our goal for years to get as many applications as possible onto one platform, so we don't have to call up so many different types of software," says Fritz. "But we wanted more than snapshots of what's going on, so we're installing new Proficy Vision software, which brings all our separate software programs into one customizable dashboard, and allows us to bring up and quickly scroll through all our individual programs that we couldn't see all at once before. Now our office managers and 56 field staffers can view water operations on the SCADA system, HVAC data, vehicle locations and status, security camera feeds, work orders and other information at the same time (Figure 1). So if there's a water main break, they can trace it with GIS, isolate it faster, check affected pump rates and tank levels, find the closest person and vehicle, tell operators which valves to close, and get specification data into the right hands more quickly."

Don Busiek, GEIP's general manager for manufacturing software, adds that Proficy Vision was just released in January, and while it renders several types software on one screen, its counterpart Proficy Mobile software will allow users to access SCADA data on tablet PCs and smart phones. "This all about understanding how operators navigate and what they need, and then coming back and providing the right data to them at the right time," says Busiek.

Training, Software and Other Tools

Apart from all the displays and technical solutions, another of the best ways to empower operators is still good, old, thorough, in-class or on-the-job training, which is often aided by online curriculum and simulations.

For instance, to prepare for commissioning and start-up on its Angel platform on western Australia's Northwest Shelf, Woodside Energy Ltd. (www.woodwide.com.au) recently decided to use UniSim operator training simulator from Honeywell Process Solutions (www.honeywellprocess.com) to instruct operators how to run its Experion C300 Process Knowledge System (PKS) and quickly diffuse potentially unsafe situations. In fact, Woodside reports employing UniSim before commissioning prevented at least five process trips.

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"The Angel training simulator was identical to our real Angel control room panel and enabled our operators to practice on the new C300 system," says Dustin Taylor, Woodside's process engineer. "We also used UniSim Design to model the process, which provided dynamic process behavior for training our panel operators. UniSim increased the competence and confidence of our staff when dealing with unsafe scenarios, plus we reduced the number of trips."

Andrew Ogden-Swift, director of technology strategy at Honeywell Process Solutions, adds, "There are several approaches to training operators including classroom, on-the-job and using standard and custom simulators. The key to proper simulation is defining the competencies needed for operators to perform their roles effectively, while designing training solutions to achieve required competencies."

Similarly, Glenn Goldney, global programs manager for Rockwell Automation's (www.rockwellautomation.com) Global Workforce Solutions (GWS) division, adds that, "Operators have been a very neglected population. Not only is there a widespread skills shortage, but their job descriptions are hard to define because of their multiple crafts and roles, and even those existing job descriptions are changing rapidly. This is why training is more important than ever for developing and retaining talent. This is why GWS also helps users segment their job structures and redistribute some responsibilities, so everyone can be more effective. For instance, we recently helped Alyeska Pipeline Service Co. (www.alyeska-pipeline.com) develop a custom job interaction and e-learning solution for operators at its emergency, back-up power plant in Valdez, Alaska, which serves transfer facilities at the end of the Trans-Alaska Pipeline."

Likewise, AES Wind Generation, a subsidiary of AES Corp. (www.aes.com) in North Palm Springs, Calif., recently installed 49 of Mitsubishi Heavy Industry's (MHI) 1-megawatt wind turbines at its Mountain View IV wind farm and implemented Iconics' (www.iconics.com) Genesis64 SCADA system and Hyper Historian, which are networked via open protocols such as OPC, take in data from Modbus TCP/IP and MHI CNET interfaces and provide AES' operators with immediate and aggregated data for monitoring and reporting. Genesis64's global aliasing function also allowed the wind farm's staff to configure controls for one turbine and then quickly import the same I/O and other settings in the other 48 turbines.

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SEE WHAT I SEE

Photo courtesy of Emerson Process Management

Figure 3: A field technician equipped with Mobile Voice and Video from Emerson Process Management can capture and transmit live video of device's he working on to experts at a distance, and get real-time feedback about correct procedures and actions to carry out.

"Many operators are increasingly overwhelmed with data because each is typically being asked to manage more systems," says Russ Agrusa, president and CEO of Iconics Inc. (www.iconics.com). "Operators must be able to integrate disparate information and software into standard, common interfaces. They need tools that can dig through "big data" and allow priority alerts to bubble up to the top."

Seeing in the Future

Naturally, as most human endeavors migrate to tablet PCs and smart phones, some even cooler tools are beginning to pop up to aid operators. One of these futuristic, collaborative tools is Mobile Voice and Video from Emerson Process Management (www.emersonprocess.com). This wearable, video-conferencing system allows field operators to point a hands-free camera at problematic equipment, and confer with technical experts at a distance (Figure 3). It was developed with components from AudiSoft (www.audisoft.net) and Frontline Communications (http://frontlinecomm.com).

"Mobile Voice and Video has full, high-definition video, but it also makes voice communications a priority," says Neil Peterson, Emerson's senior wireless marketing manager. "This means it can switch to fewer frames-per-second video based on available WiFi or cellular bandwidth to keep conferences up and running."

Jim Montague is Control's executive editor

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Wireless May Make Valve Maintenance Easier

Should you use wireless in managing your valve assets?

by Walt Boyes

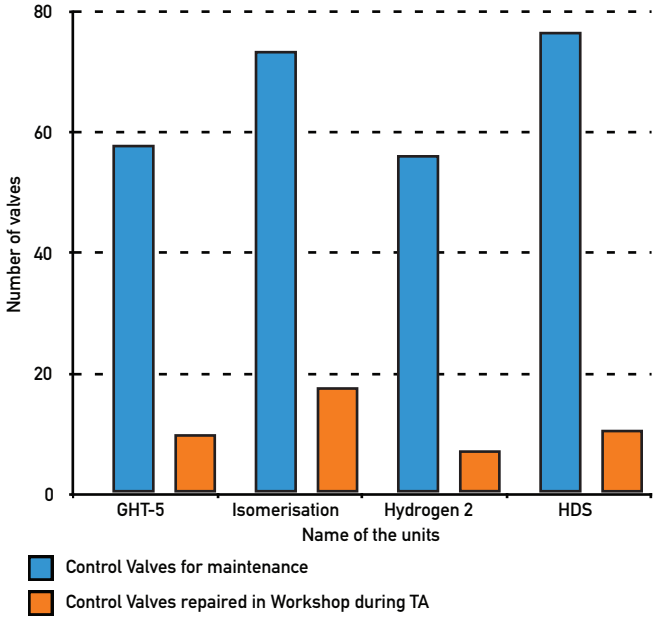
Asset management is the most difficult thing many companies do—far more difficult than actually making the products their processes are set up to make. The reason, of course, is that asset management for predictive and preventive maintenance is an add-on function in most plants. When these plants were built, there were enough people available to walk around inspecting assets for potential problems, and forty years ago the cost of simply replacing all the critical valves or motors every time there was a shutdown was relatively small, and shutdowns were relatively frequent.

But that is no longer the case. Staff reductions have limited the number of people able to walk around the plants. Running the plant at over 100% of capacity and lengthening the times between planned shutdowns has made preventive repair or replacement of assets, such as valves and motors, problematic and expensive. And with longer times between shutdowns, unplanned shutdowns due to deferred maintenance have become both more frequent and more expensive.

"We bought the very first version of AMS 1.0 from Emerson (www.emersonprocess.com) in 1999," says Gàbor Bereznai, head of the automation and electrical department for MOL, the Hungarian refining corporation, whose Danube Refinery was the 2012 HART Plant of the Year. "We have AMS, PRM from Yokogawa (www.yokogawa.com) and Honeywell's (www.honeywellprocess.com) asset management software as well."

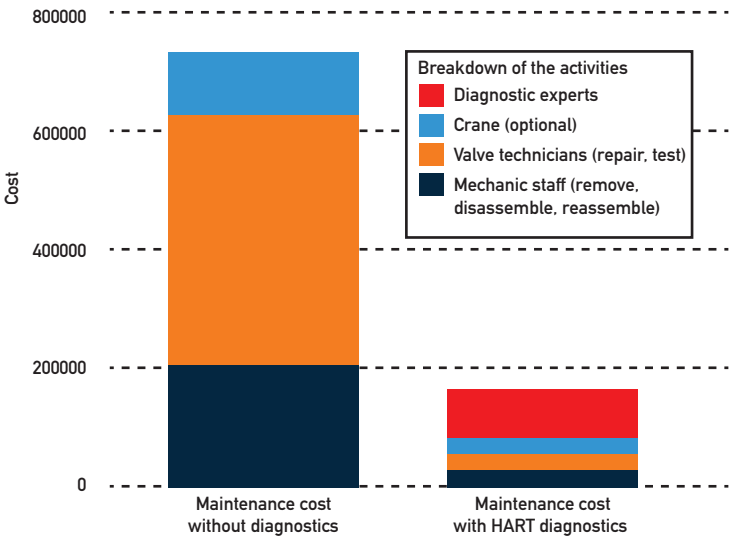
Bereznai says that the Danube refinery site has 40,000 instruments, 30,000 of which are HART devices. In addition, the refinery has somewhere between 3000 and 4000 HART valve positioners.

First, MOL connected all its HART devices through hardwired HART multiplexers to its various DCSs. Then the plant began to transition toward predictive maintenance and away from replacing all the valves when a shutdown occurred.



CONTROL VALVE REPAIR DURING TURNAROUND

Figure 1. Using HART diagnostic data ahead of time, MOL saved between $20,000 and $70,000 per turnaround.



CONTROL VALVE DIAGNOSTICS USING HART

Figure 2. Maintenance without diagnostics costs more than three times as much as that done using diagnostic data.

"You can see what has happened since we standardized on HART and Foundation fieldbus transmitters and began to enable HART valve positioners," Bereznai says. "We gather information before the turnaround using the HART diagnostic data and by doing this, we save between $20,000 and $70,000 per turnaround. So we are more predictive and proactive and less reactive." (Figure 1)

Bereznai continues, "If you look at Figure 2, you can see the breakdown of costed activities relating to valves. The costs are significantly higher without diagnostics than with HART diagnostics."

He adds, "We're replacing our analog positioners with HART, and we're experimenting with WirelessHART. We're in the early stages of using Emerson Process Management's THUM WirelessHART adapters to get diagnostic information out of HART devices without wiring them to multiplexers. We have 20 units in a test application."

He says his team also worried about EMI and other types of interference. So they conducted some nearly destructive testing. With the instrument live and broadcasting, they arc welded directly to the instrument housing, and found no detectable interference from the welding.

Bereznai believes that the significant cost differential between wiring the diagnostics-laden HART cable to a new multiplexer and using the THUM adapters will mean that they can keep their existing devices longer.

Valve diagnostics are the most important thing, he believes. "There is a huge benefit. Predictive notification can save $7000 to $100,000 or more by avoiding unplanned outages. At our facility, our most important product is diesel. One day's diesel production is worth $300,000. In 2011, we avoided a one-day outage. You can see why this is important."

To make it work, Bereznai adds his team involved everyone. "Everybody needs asset management," he says, "and it's very important to involve everybody. There were many skeptics at first, but now they're believers."

How did Bereznai and his team get started? "First, we got high level buy in," he says. "Then we standardized on HART and later Foundation fieldbus devices. Then we put together a maintenance strategy plan and an action plan. We have a living contract with our three DCS vendors to maintain the systems and keep them current. And finally, we did training. Maintenance involves all the staff, and everybody does it."

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Extracting diagnostic signals is one of the key use cases for wireless mesh networks in process plants. It would seem to be a no-brainer to jump in and start enabling wireless systems, but like MOL, most users are still doing pilot projects.

One of the reasons for this is the multiplicity (still) of wireless sensor network standards. WirelessHART, now IEC62591-WirelessHART, was the first IEC international standard, but it won't be the last. ISA100.11a will eventually be approved as a global standard, as will WIA-PA, the Chinese national standard.The ISA100.12 convergence process has been abandoned, and if end users buy some of each standard, they may actually be setting themselves up for unsafe practices and accidents. ISA100.11a devices do not interoperate with WirelessHART devices. They are not interchangeable with WirelessHART devices. And at this point, due to the failure of ISA100.12, there is no intention of making them either interchangeable or interoperable.

So what happens when a critical transmitter or wireless digital valve positioner fails during an important process condition like an upset? Somebody is detailed to run into the stores shed, get another transmitter, and go put it in . At 3 a.m., in upset conditions, it could be very easy to grab the transmitter that is *not* the one that is going to work in that application. This might cause an upset to become a disaster.

It isn't clear yet how much foothold WIA-PA will have, either inside or outside of China, but the other wireless mesh network standard, Zigbee, is making a substantial comeback.

Zigbee was investigated thoroughly by both the HART and ISA100 teams (they had many of the same members), and found not robust enough for the process industries. Unfortunately, the U.S. government decided that Zigbee would be a grand choice for the wireless sensor protocol for the Smart Grid.

Recently, several valve actuator and positioner indicator companies have decided to use Zigbee instead of WirelessHART. Even a SCADA company, exemys, (www.exemys.com) headquartered in Argentina, but selling worldwide, has standardized on Zigbee for its substation and pumping station wireless mesh networks.

So even though MOL and others have shown that there are significant reasons to use wireless mesh networks, the end users remain skeptical.

Walt Boyes is Control's Editor in Chief.

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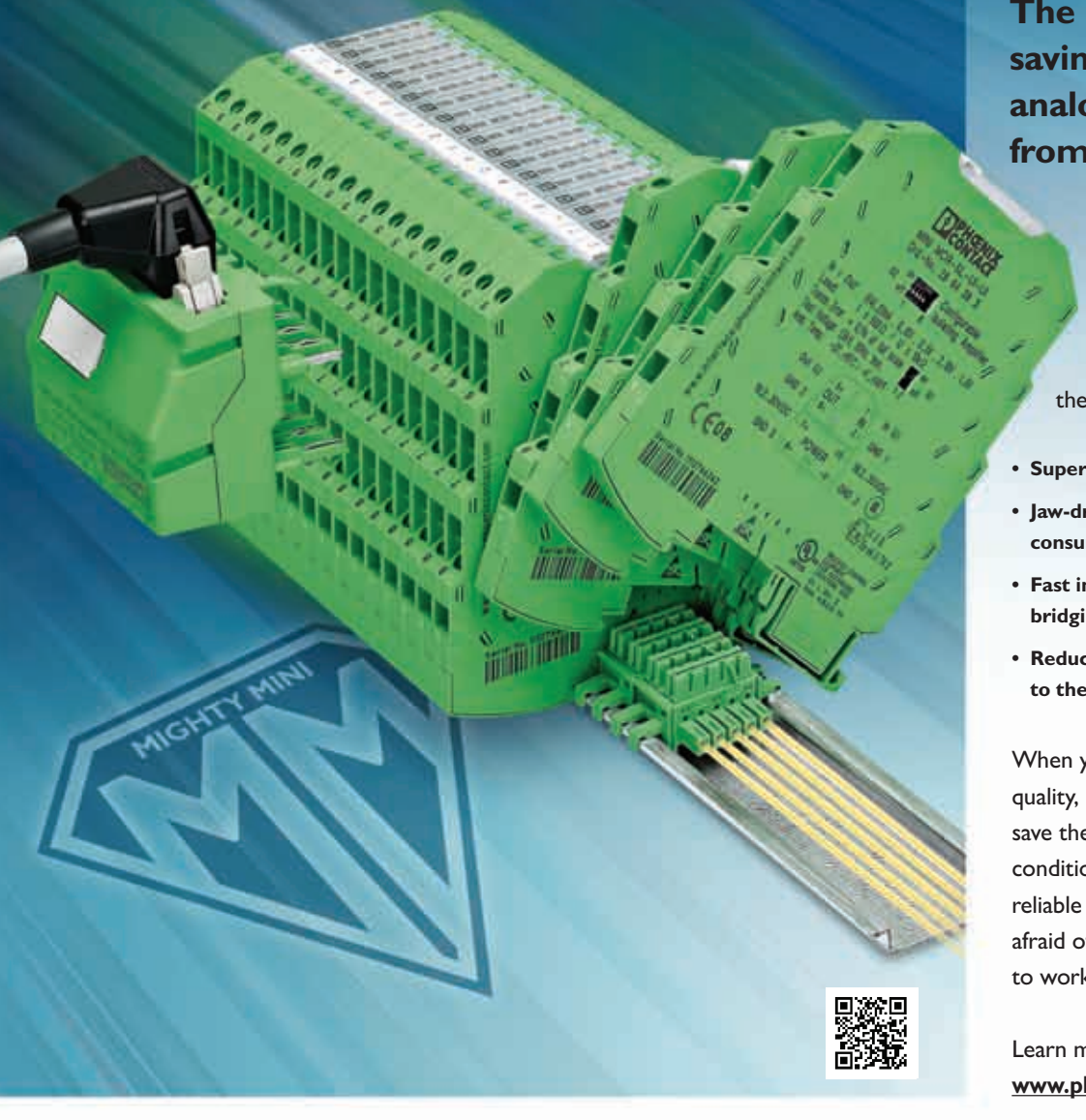

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Long-Distance Calibration

Calibration is complicated at best. Add problems of long distance, timing and customs regulations, and things get really tricky.

by Nancy Bartels

Ceuta is one of those odd corners of the globe, a political anomaly cast up after centuries of political storm. Approximately 7-sq.mi. (18 sq km) territory on the north coast of Africa just west of Morocco, it lies about 12 mi (20 km) across the Strait of Gibraltar from Spain. Its strategic location has made it a contested bit of real estate all the way back to the Carthaginians. At various times, it has been under Roman, Byzantine, Moorish, Berber and Portuguese control. Since 1580, it has been claimed by Spain, and is now a Spanish "autonomous city."

But Ceuta is no backwater. It is a very modern city with daily, high-speed ferry service to and from Cádiz in Spain. It is a free port, and oil, industry, retail and tourism drive its economy. Its population of some 78,000 gets its electricity from the Spanish electric power provider Endesa Generación (www.endesa.com).

Endesa generates 33% of Spain's electricity and has 25 plants spread over the Iberian Peninsula, plus five in the Balearic islands in the Mediterranean, nine in the Canary Islands, and two in Ceuta and Melilla, a similar city on the north coast of Africa near the Moroccan border. The power plant in Ceuta has an installed capacity of about 100 MW provided by nine diesel generators and a gas turbine.

Like most electricity providers today, Endesa's objective is to optimize its competitive position by producing electricity at a minimum cost, all while maximizing the availability of its equipment, ensuring the safety of its employees and respecting the natural environment. This is a tall order given that Endesa has electrical generating facilites spread out all over the Iberian peninsula, the southwestern Mediterannean and out in the Atlantic Ocean off the west coast of Africa.

Part of fulfilling this tall order means that keeping track of greenhouse gas emissions for regulatory and sustainability purposes is a big issue for Endesa. This effort is supported by Endress+Hauser's (www.endress.com) Promass flowmeters installed on its facilities' gensets. But installing flowmeters is only part of the solution. Those meters have to be calibrated, in Ceuta's case, every three years. And here's where things get a bit more complicated.

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Germán Canosa Murcia, electrical maintenance technician at Endesa in Ceuta, explains: "The calibration of these flowmeters is extremely important because first, the Spanish electricity system operator, Red Eléctrica of Spain SA, requires testing on certain flowmeters to ensure adequate performance, and these have to be calibrated every three years. We also have to properly calculate fuel consumption and CO_2 emissions to comply with Spanish and European Union regulations. Finally, we have an internal directive of the company to keep track of these things." (Figure 1)

But regulatory and corporate demands aside, the calibration of the 11 flowmeters at the Ceuta facility present other challenges. All the flowmeters could not be removed at the same time because each genset has to be stopped when the flowmeter is removed, and Ceuta had only one backup flowmeter. Calibrating all of them at once would virtually shut down the facility. But doing them one at a time also presented problems. The process would drag out over nearly a year and incur extra costs.

Canosa says, "The original plan was to remove a flowmeter, replace it with a backup and send the flowmeter back to the manufacturer for calibration. But Ceuta has special tax and customs procedures, and the equipment must pass both procedures when being sent and when it is returned. This fact, coupled with the transporting and the calibration time, could take as long as a month for each one. With 11 flowmeters, the total calibration time could be up to 11 months."

At that point in 2010, Endesa began conversations with Endress+Hauser in Spain to find a better way. The solution was to use Endress+Hauser's on-site calibration service, one which the company says is unique in the industry. The service works this way. Once Endress+Hauser consults with a company to find out the scope of its needs and its plant availability, a time for the calibration is scheduled. The entire kit of necessary calibration equipment is packed in three flight cases, and a calibration specialist accompanies it to the facility, where the required calibration is carried out (Figures 2 and 3). At the end of the process, a Certificate of Calibration of unit under test (UUT) and the master meter's Swiss Calibration Services (SCS) certificate is delivered.

At Ceuta, says Canosa: "First our maintenance people dismantled the flowmeters, and then cleaned and decontaminated them. Then the Endress+Hauser engineers connected the flowmeter to the testing computer, and checked and verified its calibration. If the calibration tests showed that the measurements were not as specified, the engineers recalibrated the system until the correct accuracy was achieved. The calibration takes between one and two hours. The entire process, including disassembly, assembly and calibration does not exceed more than three of four hours per flowmeter."

Canosa continues, "The advantages of on-site calibration are evident. In just four or five days, we had calibrated all the flowmeters. We also saved money by not having to pay for the transport and the special tax and customs procedures involved in shipping them back to the manufacturer."

Endesa has not limited its use of Endress+Hauser's services to Ceuta. The Coriolis flowmeters in service in its diesel plants in Melilla, just up the coast from Ceuta, on the Balearics in the Mediterranean, and in the Canary Islands, about 62 mi (100 km) off the coast of western Africa, have also benefited from the on-site calibration service.

As for Ceuta, Canosa says the facility is already planning to use the

MAN ON THE GROUND

Figure 1. Germán Canosa Murcia says the on-site system cut calibration time at the Ceuta plant from months to days.

HOUSE CALL

Figure 2. A specialist from Endress+Hauser handles calibration complexities on-site, saving down time and shipping expenses.

ALL PACKED UP

Figure 3. The Endress+Hauser on-site calibration kit ships in three flight cases, bringing calibration directly to the sensors.

service again next year when the next three-year calibration is required. "This time we will expand the on-site services to include the calibration of the temperature sensors within our flowmeters. This will increase the service cost, but it will guarantee us more accurate temperature measurements. ■

Nancy Bartels is Control's managing editor. Katherine Bonfante, Control's senior digital managing editor, also contributed to this story.

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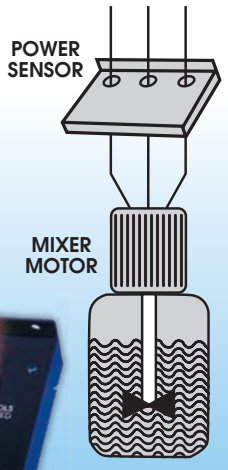

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DAN HEBERT
SENIOR TECHNICAL EDITOR
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Should You Manage IT from Off-Site?

Many process plants and process automation departments struggle with IT issues, particularly those closely related to process control and monitoring. While some larger plants and companies have sufficient IT staff conversant in automation issues, most do not, leaving automation professionals to fill the gap.

One source for assistance is off-site IT service providers. These firms run the gamut in terms of the services and assistance they provide, from basic data backup to full remote monitoring and support.

Data backup tasks are performed in-house at many process plants, but some facilities find it tempting to neglect or postpone them because day-to-day operations may continue unimpeded for months or even years with no data storage failures. But inevitably, a failure will occur, and it will be hugely disruptive if proper backup procedures haven't been followed.

Off-site data storage firms can provide the discipline of regularly scheduled backups, offloading in-house resources from this tedious task. Firms such as Amazon, Google and Rackspace provide these services at very low prices, albeit with correspondingly low levels of specialized support, particularly for customers in niche markets like the process industry.

For comprehensive IT support tailored to their specific needs, process plants that primarily rely on one supplier for most of their automation hardware and software may wish to engage this preferred supplier for offsite IT assistance. When this option is chosen, process automation and IT professionals can expect a much higher level of service, but at substantially higher costs. Major automation suppliers have large numbers of personnel dedicated to servicing the automation/IT sector, and they bring a much deeper understanding of process automation.

If your plant uses automation hardware and software from a variety of suppliers, and you need a higher level and a greater range of services than are provided by the typical data backup firm, an automation solutions provider could be your best option.

"Our company provides five basic services from our PlantFloor24 Operations Center: backup and recovery, software updates and patch management, incident management, real-time control system monitoring and online control system edits," says Kirk Norris, the senior vice president for strategic manufacturing solutions at Maverick Technologies (www.mavtechglobal.com), an automation solutions provider based in St. Louis.

Backup and recovery services provided by firms such as Maverick and by automation suppliers are much more in-depth than those provided by the likes of Google because of their domain expertise.

Software updates are critical for process plants, and each update requires decisions to be made with respect to acceptance and implementation. If updates are ignored, then known bugs will remain, often causing significant operational problems and raising security issues. But blind acceptance of updates can be troublesome too, as an update to one program may cause it to cease functioning at points of interaction with other software.

An automation supplier or an automation solutions provider can provide valuable assistance by testing updates on hardware and software similar to that installed and running in your plant.

"We're able to replicate our clients' entire automation system at our PlantFloor24 Operations Center. We can then test software updates and make sure that each doesn't cause unintended outcomes. After testing, we can work with the client to remotely update their systems" explains Norris.

In a similar fashion, automation suppliers and automation solution providers can provide related automaton/IT services such as incident management, real-time control system monitoring and online control system edits. ■

Automation suppliers and solutions providers bring a deep understanding of process automation and IT to the table,

Loop Drawings for "Smart" Instruments

This column is moderated by Béla Lipták (http://belaliptakpe.com/), automation and safety consultant, who is also the editor of the *Instrument and Automation Engineers' Handbook* (IAEH). If you would like to become a contributing author of the 5th edition, or if you have an automation related question for this column, write to liptakbela@aol.com

Q I am looking for information on loop drawings for smart instruments and sample drawings. If you could point me in the right direction it would be appreciated.

PAUL BULMER
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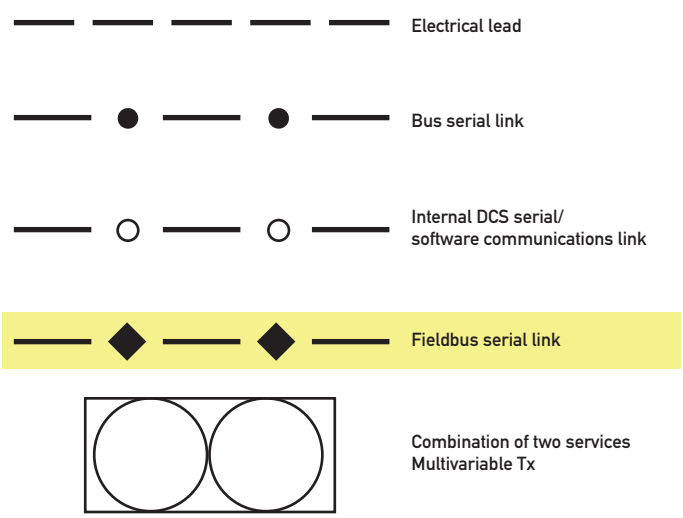
A Loop drawings for "smart instruments" are the same as for analog loops, except for the communication links between the components (Figure 1). The loop component symbols are given in ANSI/ISA5.1 (2009).

As to the need for loop diagrams, there is disagreement. In the view of American engineering design firms, loop drawings are not really necessary (are a luxury) because if the P&ID flow sheets are sufficiently detailed, then the information that the loop drawings provide can be obtained from the instrument index, specifications, I/O lists and wiring diagrams, piping diagrams, logics, cable schedules, etc. This view has evolved because the main goal of these firms is to minimize the number of man-hour-consuming documents, and thereby gain a competitive edge by tightening budgets through limiting engineering costs.

In other offices and in other parts of the world, such as Asia, the criterion is total cost, which includes not only design, but also operating, maintenance and insurance costs, and from that perspective, loop drawings are desirable because they make the loops easy to understand, as you do not need to look at several documents. Those firms consider the generating of loop diagrams valuable and use ISA5.4 as



P&ID DOCUMENTATION

Figure 1: Communication link symbols.

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the basis, although it has not been updated for over a decade and does not give examples for fieldbus loops. For this group of engineers, it would be useful if ISA5.4 covered the protocols used; e.g., Foundation fieldbus, Profibus, Profinet, HART, Wireless HART, DeviceNET, ControlNET, ASi, etc.

So it seems that the main cause of the elimination of loop drawings is economic and can be short-sighted, because having them serves not only operational and maintenance convenience, but also can improve safety and thereby lower insurance costs.

BÉLA LIPTÁK
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A Figure 1 shows the P&ID representation that I have been using based on latest version of ISA5.1, and Figure 2 is a sample of a segment diagram, which can be considered to be a replacement for the loop diagrams that I use when presenting certified training for the Fieldbus Foundation.

There is a trend toward using database-driven loop diagrams or their equivalent. This is well and good for the large facilities, however, there are far more smaller operations that continue to rely on the printed word or manually created CAD drawings for installation, commissioning and troubleshooting.

It may save a few pennies now, but if you need to reconstruct a loop during or after an incident or at the proverbial 3 a.m. on Saturday morning, the lost production revenues quickly exceed the cost of preparing the minimum level of documentation. We need to get more folks thinking total lifecycle cost rather than just their portion of the lifecycle.

IAN VERHAPPEN
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A I have not seen a "true" loop drawing in over 15 years. They are now merely a wiring drawing in another form and are more geared to construction/commissioning rather than operations/maintenance.

A true loop drawing would convey some sense of process functionality. There should be some indication of the related components. Often there would also be a simplified process sketch. Furthermore, many loop drawings do not even show the power supply details pertaining to the

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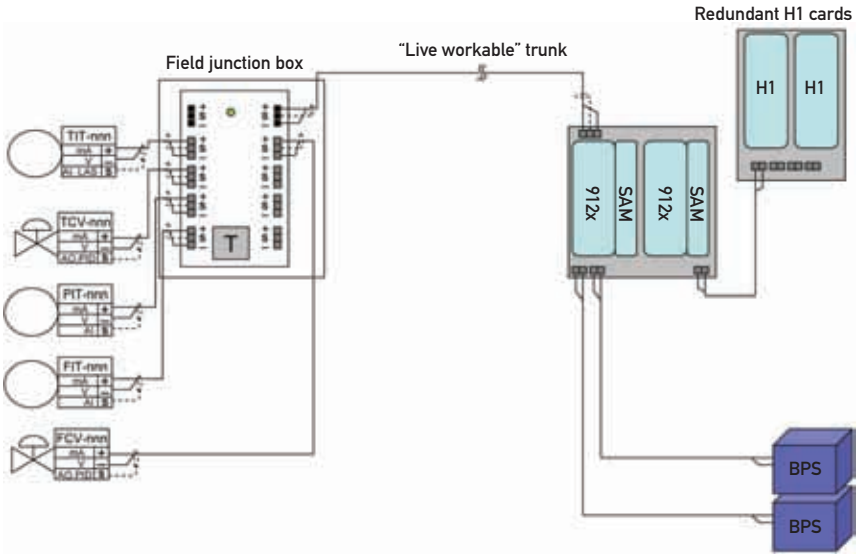

REDUNDANT FISCO SEGMENT DIAGRAM— COMPONENTS

Figure 2: An example of a segment diagram that serves the function of a loop diagram.

instrument; e.g., how to isolate the 24VDC from an instrument; what are the fuse ratings? It makes me wonder if anyone actually uses loop drawings anymore.

A lot of this arises from the constraints imposed by drawing automation tools/instrument databases.

SIMON LUCCHINI
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A Control system deliverables are moving away from the realms of ISA-based conventional drafting as they are more and more driven by the self-documenting software tools used. Engineers do not need to do as-built drawings as a separate exercise.

Loop drawings' content is driven by the client maintenance person who is using it. In most cases, it could be too simple as the diagnostics tool, and one does not really need reference to loops as there are not too many wires to trace in the field or in the system cabinets.

Clients are moving away from individual loop drawings, and are content with segment drawings irrespective of the fieldbus technology used.

Clients are demanding more value for the money they spend, and want to limit engineering costs as the hardware has been already made commercially off the shelf (COTS).

L. RAJAGOPALAN (RAJ)
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As far as I am aware, there are no international standards yet for "smart" instrument loop drawings. You can either follow the ISA standard (S5.1) or the client's standard. However, a cover sheet is required to explain all the symbols used in the drawings.

Smart instruments connected to an asset management system require additional components, depending on what protocol is used (e.g., Foundation fieldbus, Profibus, Profinet, HART, Wireless HART, DeviceNET, ControlNET, ASi etc).

RAJ SREENEVASAN
binney4family@internode.on.net

A The insurance cost would be high after a fire or an accident that occurs to any plant that has no loop drawings. The responsibility is the owner's if he or she takes the risk.

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ISA needs a universal language and interpretation on loop drawings.

GERALD LIU, P. ENG.
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A I have witnessed a real move away from loop drawings in the last 10 to 15 years. This has paralleled the overall tightening of budgets, both for capital projects, which has translated to shedding any "optional" design documentation, such as loop drawings, and for plant maintenance and engineering support, which has translated to reduced E&I technician and controls engineering staffing levels and higher turnover.

In a lean plant environment, loop drawings are more of a luxury, mostly duplicating information found elsewhere, even though elsewhere means at least four other documents (P&ID, I/O wiring diagrams, piping diagrams, instrument spec sheets, and possibly SAMAs, logics, cable schedules and instrument lists). At the same time, in some plants, there has been a greater adoption of SAMA diagrams, sometimes better referred to as "control functional diagrams," loosely based on the old SAMA standard, but updated and adopted to control of industrial processes.

I agree as well that loop drawings are particularly useful, especially to plant personnel, because one must not refer to a number of other documents to get the whole picture of a loop as historically provided on a single loop drawing. Nonetheless, loop drawings have become viewed as a luxury by those seeking places to cut design and engineering costs. It's more difficult to assign a value to the maintenance and reliability costs attributable to inadequate or less effective/efficient forms of documentation, while it's relatively easy on a capital project to decide it's not needed for installation and saves X design dollars.

Another trend, perhaps a factor in the decline of loop drawings, has been reduced participation and influence by plant maintenance personnel on capital projects. I recall a time when E&I tech input carried a fair amount of weight during the design and engineering phase, though I'm sure that also varies considerably, depending on the corporate culture.

R. H. (RICK) MEEKER, JR., PE
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A Loop drawings for smart instruments are no different than those for conventional instrumentation. The difference in the two systems is the digital component of the signal. The HART Communications protocol is used by most smart instrument vendors to impose a digital signal on the 4-20 mA signal. This allows additional information to be carried on the instrument wiring matrix. The addition of a digital component in the signal also allows other wiring methods, such as fieldbus and Ethernet, to be used instead of conventional wiring.

For examples of loop drawings, I suggest you search Google Images for "instrument loop drawings" for several styles of loop diagrams.

JOHN DRESSEL
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A In my experience, loop drawings are a must-have. They help technicians in troubleshooting. If you are using software, like InTools for design, they are easily done.

H S GAMBHIR
Harvindar.S.Gambhir@ril.com

A We *need* to get more folks thinking lifecycle cost rather than just their portion of the lifecycle.

GEORGE ERK
georgerk1930@gmail.com

For more answers from our experts, including Thomas C. McAvinew, Dick Caro, Bill Hawkins and John Rezabek, go to www.controlglobal.com/1303_ATE.html.

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"For more than 40 years, we have been a leader in combustion gas analysis," says Mike Fuller, divison VP of sales and marketing and business development for Ametek Process Instruments, "and we believe the WDG-V is the combustion analyzer of the future." ● WDG analyzers are based on a zirconium oxide cell that provides a reliable and cost-effective solution for measuring excess oxygen in flue gas as well as CO and methane levels.

This information allows operators to obtain the highest fuel efficiency, while lowering emissions for NOx, CO and CO_2. The zirconium oxide cell responds to the difference between the concentration of oxygen in the flue gas versus an air reference. To assure complete combustion, the flue gas should contain several percent oxygen. The optimum excess oxygen concentration is dependent on the fuel type (natural gas, hydrocarbon liquids and coal).

The WDG-V mounts directly to the process flange, and is heated to maintain all sample-wetted components above the acid dewpoint. Its air-operated aspirator draws a sample into the analyzer and returns it to the process. A portion of the sample rises into the convection loop past the combustibles and oxygen cells, and then back into the process.

This design gives a very fast response and is perfect for process heaters. It features a reduced-drift, hot-wire catalytic detector that is resistant to sulfur dioxide (SO_2) degradation, and the instrument is suitable for process streams up to 3200 °F (1760 °C).

"The role of combustion analyzers in control and safety functions is evolving rapidly," Fuller says. "Maximizing fuel efficiency, while reducing emissions from combustion processes, requires the use of aggressive operating setpoints that dictate the need for additional layers of safety for risk reduction." He adds, "The WDG-V was designed to meet the SIL-2 standard, so that it can be a key part of a safety instrumented system (SIS). The WDG's aspirator design has always provided a reasonable response time, but our customers needed tighter control on combustion parameters. This means faster response, even with flame arresters installed."

Fuller goes on, "The flow path through the WDG-V was completely redesigned, so it provides the fastest response of any extractive combustion gas analyzer, and it has the ability to predict a pending sensor failure and monitor flow characteristics to the sample cell."

The redesigned combustion analyzer features an improved aspirator with larger orifice sizes; low-flow sample alarm that monitors combustion gas flow and indicates low sample flow; automatic verification of cell and detector integrity ensuring proper accuracy and operation; and cell and detector age tracking for proactive calibration or service scheduling.

The WDG-V can be installed as either a standalone analyzer with analog/HART, discrete and Modbus RS-485 bi-directional communications, or supplied in a typical "sensor/controller" configuration with the addition of an AME Vision HMI that provides a graphical display and membrane keypad, Modbus, TCP/IP Ethernet connection, embedded web-enabled interface and USB data collection port.

Ametek's WDG-V flue gas combustion analyzer meets SIL-2 standards for safety instrumented systems.

"The WDG-V builds on the success of the WDG-IV by adding key customer-valued features," Fuller says. "The intuitive color graphical user interface on the AMEVision host module, which provides Modbus, TCP/IP, web-enabled interface and USB data port, is an Ametek Thermox first. The diagnostics that predict the lifetime of the sensor and the low-flow sample alarm that monitors combustion gas flow at the sensors set the WDG-V apart from previous generations. And the WDG-V is the first generation designed to be SIL-2 and part of a safety instrumented system implementation.

"Our design goal was to provide as much sensor and calibration performance monitoring, diagnostic self-checks and operational data as possible to the user through graphical display, data logging and digital communication. What we have been able to do is to provide a complete solution for combustion process control and safety. We can offer the end user all of the information required to implement predictive and proactive maintenance programs in addition to a highly reliable combustion analyzer." ■

For more information, contact Ametek Process Instruments at 412-828-9040 or www.ametekpi.com.

Power Up with a New Kind of Redundancy!

Pepperl+Fuchs has introduced the PS3500-DM—a new diagnostics module for its PS3500 power supplies—bringing a new level of reliability by continuously monitoring the conditions and health of the PS3500 power supplies and primary side power conditions. The diagnostic module has four layers of monitoring—mains, output, power supplies and diagnostics to maintain system integrity. The PS3500 DM is easily integrated into plant asset management systems through RS485/HART, EDDL or FDT/DTM technologies, and provides intelligent power and real-time diagnostics.

PS3500 power supplies provide N+1 or N+N redundancy, high immunity and industry-leading efficiency for the most demanding environments. Featuring adjustable output voltages between 22.5 VDC and 30 VDC, the product has built-in alarm outputs, a fanless design, hot-swappable module replacement, and boasts an efficiency of up to 91%, according to the company's product specifications.

Pepperl+Fuchs' product manager, Robert Schosker, says, "Pepperl+Fuchs needed a robust and clean power supply to support our other product lines, such as fieldbus (FieldConnex) and HART. These two product lines require clean, efficient and reliable power because signal quality is important due to their digital communications."

Modern continuous processes operate for long periods without downtime, and most field instruments have a power supply, or their power is supplied by the output loop. Digital (smart) field instruments have extremely long, useful lives, with very low mean time between failures (MTBFs). The power supplies also must have similarly low MTBFs.

"These demanding conditions necessitate N+1 and N+N redundancy," Shosker said. "N+1 redundancy means that multiple power supply modules (N) have a backup power supply module. That's the +1. All modules within the configuration share the load. If one module fails, the working modules are able to continue load sharing with no system degradation. This is simple and affordable, and guarantees that the system will keep operating even during a power supply failure."

Each 24-VDC, 15-A power supply module plugs directly into a 3- or 6-position backplane, which allows a maximum capacity of 45A or 90A of continuous uninterrupted power. The entire system is rated for IP20 protection class in accordance with EN60529, and has an operating temperature rating of -25 °C to 45 °C at a relative humidity of less than 95%, non-condensing.

Input voltages from 90 VAC to 250 VAC or 90 VDC to 300 VDC are permissible. Current required is 15 A. Output voltage is adjusted via an easy-access, backplane-mounted potentiometer. The system is rated Class I, ATEX Zone 2 and Division 2 certified by Underwriters Laboratories. To make the most use of the PS3500, users should add a diagnostic module to the backplane. This module adds the most protection possible, and it should be used with all mission-critical loops. It's also rated Class I/Division 2, Groups A, B, C, D, T4 and Class I/Zone2 Groups IIC T4.

The PS3500 series field power supplyoffers N+1 and N+N redundancy to ensure a low mean time between failures.

The power supply diagnostic module permits real-time input and output power monitoring with a complete suite of diagnostics and fault indication with configurable warning and alarm levels. Its bus output is RS-485 (HART), and is suitable for integration with the plant's asset management system with its EDDL and DTMs. Its alarm output is a single Form C relay (NO/C/NC).

"Use of the diagnostic module," Schosker says, "means that maintenance and operations personnel can get early warnings of faults or impending failures from the power supply, enabling them to schedule maintenance or switch out the faulty unit before a problem causes unexpected and expensive downtime." ■

For more information, call 330 486-0002 or go to www.pepperl-fuchs.us.

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MPC — Past, Present and Future, Part 2

Greg McMillan and Stan Weiner bring their wits and more than 66 years of process control experience to bear on your questions, comments, and problems. Write to them at controltalk@putman.net.

Stan: In this multipart part series, Mark Darby, principal at CMiD Solutions, is sharing his thoughts on the scope of model predictive control (MPC) applications. The focus in Part 2 is on model development and tuning, but we are free to roam. Mark, since models are only as good as the data, what are recommendations for testing?

Mark: You need to test at not only the nominal operating point, but also near expected constraint limits. Pre-tests are an accepted practice to get step sizes and time horizons. We also need to verify that the scan time is fast enough and the trigger level is small enough for data historians and wireless transmitters. We prefer that compression and filters be removed, so we can get raw data. A separate data collection to get around these limitations is commonly used.

Greg: For us, the pre-tests, which we called bump tests, were separate steps to one manipulated variable at a time. We often would find improvements that needed to be made in instruments or control valves before we did the tests to build the model.

Stan: What automated testing is being used?

Mark: Manual methods are still used, but automatic testing approaches are increasingly being applied. These use random sequences, such as a pseudo-random binary sequence or generalized binary noise. Closed-loop testing approaches, based on a preliminary model, are also being applied as a means of keeping the process in an acceptable range, and reducing the effort involved in plant testing—both for the initial application and to update the MPC model for changes in equipment or operating conditions. Closed-loop testing continues to be an active development area.

Stan: If the testing and some of the model analysis are automated, what does the process control engineer need to do?

Mark: The intent of these enhancements is to simplify the tasks of the control engineer, not remove his involvement. The control engineer is required to make decisions regarding test specifics, such as move sizes and frequency, and determining when testing can be terminated. In model identification, decisions must be made as to which data and variables to use; then, which models are going into the controller. For example, should you include a weak model? Obviously, this requires process knowledge and MPC expertise. A sharp person mentored by a gray-hair can lead projects after several years of applications experience.

Greg: Getting back to the data, what is most important?

Mark: You want good, rich data, meaning significant movement in the manipulated variables at varying steps and durations to get accurate models. But it does not end there. You need to look for consistency in the resulting models. Use engineering knowledge and available models or simulators to confirm or modify gains. Don't shortchange this step. Gain ratios are very important, especially for larger controllers. Empirical identification does not enforce relationships, such as material balances, so there can be a fictional degree of freedom (DOF) that the MPC steady-state optimizer—either a linear program (LP) or a quadratic program (QP)—may exploit. As discussed previously, techniques are available now to assist with this analysis and adjust gains to improve the model conditioning, which frees up the engineer to take a higher level supervisory role.

Stan: How do you get the MPC ready to go online?

Mark: Offline tuning relies on the built-in simulator. Most important is getting the steady-state behavior of the controller right. Simulation can also serve to identify errors on the model gains, for example, observing a manipulated variable (MV) moving in the wrong direction at steady state. You want initial tuning for the dynamic parameters to be in the ball park. Regarding steady state, you determine how you want the MPC to push manipulated and constraint variables based on cost factors and priorities, making sure you are enforcing the right constraints. Unlike override control, which is sequential, by picking one constraint, the optimization is simultaneous, multivariable and predictive, taking into account future violations. Some MPCs use move suppression, and some reference trajectory to affect MV aggressiveness. Penalty-on-error is used for both constraint or quality variables (QV) and controlled variables (CV). We have evolved to not distinguish between QV and CV except as presented to the operator.

Greg: What kind of expertise do companies have and need?

Mark: Some on-site expertise with remote access or revisits by external expertise is generally the approach for most plants. Large companies with a good history of MPC have gotten good at it. In general, basic and advanced process control groups got hurt in the 1990s. It used to be that management were practitioners who understood and appreciated the technology and the expertise. Now it is a mixed bag, and you may need to convince management of the resource requirement.

Stan: How can you reduce the time horizon to reduce test time and provide better short-term resolution of fast dynamics for a given number of data points over the horizon?

Mark: Regulatory design impacts the settling time of the MPC controller. An example is having the setpoint of a temperature cascade control loop for a distillation column as a manipulated variable. Controlling levels associated with large holdups in the MPC can also reduce the settling time, although this is normally done to provide better constraint control. If you don't need to handle the level control for constraint control/coordination, keeping the level in the regulatory control system is fine. If a process variable has a very large time constant, modeling the variable as integrating instead of a self-regulating can dramatically shorten the time horizon. Depending on the particular MPC, the integrator approach may take up a DOF in the LP or QP optimizer.

Greg: I have found that treating loops with a large time constant as near-integrators can shorten the tuning test time by 96%, making tests less vulnerable to disturbances and less disruptive.

Stan: For PID loops we have auto tuners and adaptive control. How do you tune an MPC once it goes online?

Mark: You may need to revisit constraint priorities, but hopefully you've got most of these priorities right in the simulator. The tuning process then becomes one of setting weights to get the right trade-off between tightness of CV and MV movement. Note that you can't tune your way around a poor model, which you might do in PID, for inadequate knowledge of process dynamics. You can't just increase move suppression. The steady-state part can still give you grief. It is not unusual during online tuning to realize you have model problems causing you to revisit your model choices.

Stan: What can you do in the MPC to deal with changes in dynamics and problems with measurements and final control elements until fixed?

Mark: Most MPC packages allow customization, for example, the capability to switch a model or write to model and tuning parameters, and this is often used. Process gains or a multiplier can typically be accessed. Static transformation of controlled and manipulated variables is also a standard feature; a popular option is piecewise linearization functionality. You can turn off a section of the MPC where a controlled variable or manipulated variable is unavailable.

Stan: Some MPCs can execute as fast as one second, creating opportunities to use MPC for decoupling and optimization of relatively fast loops where a PID execution time does not need to be less than one second.

Greg: Go to www.controlglobal.com/1303_ControlTalk.html for more advanced control myths. ■

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Get into the Uncomfort Zone

I've probably said it before, but after a dozen or so interviews, I usually begin to notice some common threads and trends. Sometimes, these repeated themes are indicated as much by what my sources don't say as what they do say. For example, this month's cover article, "Operator Performance Pumps Up," is all about the multiplying fruit salad of tools and methods for improving operators' situational awareness and their ability to manage process applications efficiently, safely and productively. Everyone was talking focused and prioritized data, uncluttered and efficient HMIs, efforts and rules to reduce fatigue, rationalized alerts and alarms, unified software platforms, simulations, wearable cameras and video-conferencing, and even eye-tracking cameras and ways to monitor operators' attention and alertness.

Oh sure, in-class and on-the-job training were mentioned, however, I got the feeling that everyone was impatient to get done with talking about training quickly and on to the next glitzy technical innovation. No one actually said it, but it seemed from the lip service it received that training was old-fashioned and just plain boring. And maybe it is, but I still can't think of anything more essential to improving operator performance or the appropriate actions of anyone in a critical situation.

Training has always been essential to steadily building the skills that everybody needs to master their crafts, including athletes, soldiers, musicians, firefighters, emergency medical technicians (EMTs) and physicians, to name a few. Repetitive practice and drilling gradually combine neural pathways in the brain, and these links allow participants to carry out complex actions faster and more efficiently than someone who hasn't practiced those skills. More recent research shows that sleep and dreaming after practice helps set these new skills in mental concrete, so they can be called on later.

But, as worthwhile and relatively inexpensive as training is, it's still boring—a time-sucking job that requires patient and methodical instruction by teachers and willingness to practice, repetition and evaluation by students. On-screen courses and simulations can help, but I suspect most of those annoying hours still have to be put in, and frequent refreshers will be needed later. The firefighters and EMTs that I used to cover were forever drilling on all the scenarios they might encounter so they wouldn't risk wasting precious seconds during a fire or medical emergency.

Faced with training's perceived drudgery, many operations supervisors, process engineers, system integrators and managers can be forgiven for wanting some other solutions for improving operator performance. Implementing muted-color displays, ergonomic furniture, exercise equipment near the control room or co-joined, easily accessible software platforms just has to be easier than pounding new skills into often-resistant human heads, right?

This preference is reinforced by the fact that engineering in general and process control in particular aren't exactly famous for calling on or nurturing people skills. And while process control and automation are all about having devices take over formerly manual tasks, countless optimization, safety-related and quality control jobs remain for operators to do, and they need the training and skills to perform them.

As a result, training needs advocates who will quantify and promote its efficiency and financial benefits. And these supporters of more and better training often will have to agitate their managers into enabling routine, but vital instructional programs. I know that bugging my sources into giving me interviews and information can be very irritating, but I believe it still has a positive outcome.

So, while software and components may replace operators someday, it's not today. For now, slick HMIs, ergonomic workstations, sophisticated alerts and alarms and situational awareness software are the gravy, and they still need a bed of meat-and-potatoes training. ■

Supporters of more and better training will often have to agitate managers into enabling routine, but vital instructional programs.

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